THE ELECTRICAL REVIEW

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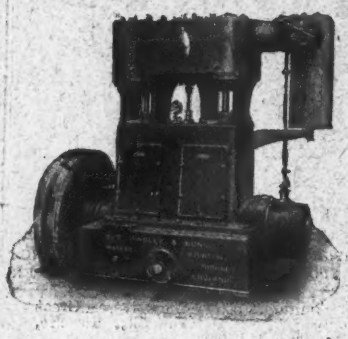

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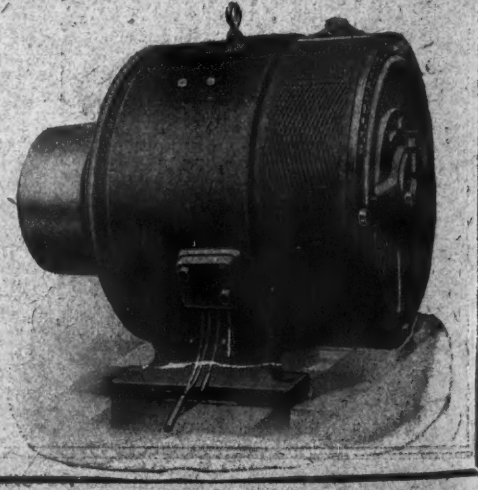

THE

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THE MANCHESTER CONFERENCE.

WHATEVER may be the final result of the conference convened by the Board of Trade, Friday, March 2nd, 1917, will always stand out as a landmark in the history of the electricity supply industry of this country. Our readers will recollect that, prior to the Board's circular letter regarding coal economy, the engineers of the supply undertakings of Lancashire and Cheshire held a meeting last spring, and appointed a representative committee of 12 to investigate the possibilities of interconnecting systems in suitable districts. After much work had been done, a preliminary report was issued in September, which outlined a scheme for dealing with four groups of undertakings, which were favourably situated, and a recommendation was made that a conference of the authorities concerned should be convened by the Board of Trade, and be presided over by a Government representative. After some delay, arising out of departmental methods and the replacement of the Coalition Government by the present War Cabinet, the Board of Trade adopted the suggestion, and appointed its Parliamentary Secretary, Mr. G. H. Roberts, M.P., to preside over it, and he was accompanied by important permanent officials.

We commend to the full consideration of our readers the remarks by this gentleman which appear elsewhere in this issue in the account of the proceedings in Manchester. From these it is quite clear that the Board of Trade is now being directed by courageous gentlemen who have a clear conception of what this country owes to electricity for the part which it has played in this war in getting a quick output of munitions, and who are determined to have the supply of it put on a satisfactory basis, from the points of view of both cheapness and security of supply. Mr. Roberts showed that he had a firm grasp of the part which electricity is destined to play in the national life, both in assisting cheap production in industry and in securing the more efficient use of our coal. He also showed a refreshing courage in indicating that the Government's views on electricity supply had been conceived on too narrow lines in the past, and that broader views must in future prevail. The Town Clerk of Salford elaborated this point, and gave convincing reasons why electricity supply should not be confined by municipal frontiers—a happy expression of which more will be heard in years to come. An essential feature of the Lancashire and Cheshire scheme is that a working arrangement should be made between the proposed Municipal Board of Management and the Lancashire Electric Power Co. Considering the unfortunate antagonism which has existed in the past between municipalities and power companies, it is gratifying to note that Dr. Parshall indicated the willingness of his company to make such an arrangement. The conference of 125 delegates, representing 42 undertakings, showed remarkable unanimity in support of the report under consideration, and it is of good augury for the future

that no dissentient voice was heard, and that there was no adverse criticism. The Board of Trade has now requested the Interconnection Committee to proceed to elaborate its scheme, and to bring forward detailed proposals for its approval.

There can be no doubt that the Lancashire Committee will follow up energetically by preparing a scheme based on voluntary co-operation, with a view to a portion of it being at work next winter, as it is notorious that coal difficulties, shortage of plant, &c., demand prompt measures in the national interest. The work of the Committee and of those whom it calls into its counsels will be followed sympathetically and with keen interest throughout the country.

In connection with this matter, it is pertinent to call attention to the fact that the report of the Board of Trade Commitee on the Electrical Industry after the War has not yet been published. We suggest that it might be of great use to the framers of the Lancashire and other linking-up schemes, at this stage, and we should welcome an announcement that it will shortly be available. We believe that the Committee's proceedings reached the concluding stage last week. In the meantime, it is valuable to note that the Board of Trade appears to be willing to consider favourably the promotion of any linking-up and development scheme which is prepared by the supply authorities, who alone can have full knowledge of the local conditions to be catered for. In conclusion, particular note should be taken of the stress laid by several speakers on the excellent feature in the scheme that local autonomy would continue in regard to the supply of electricity. This is a statesmanlike feature which bids fair to secure the goodwill of the permanent officials of the authorities concerned, and we commend it to others who have similar projects in preparation.

PROBLEMS OF INDUSTRY.

We have received a reprint of the views on "Industrial Problems After the War" expressed in a contemporary by Mr. W. L. Hichens, the chairman of Messrs. Cammell, Laird and Co., Ltd. The opinions of Mr. Hichens, being those of a leader of industry, are well worthy of study, and they are the more so because of their timeliness. Of course, it is impossible for anybody to traverse such ground without saying some things that are already familiar to those who have made a close study of such matters during, say, the past two years. Recognising that things industrial can never be the same after the war as they were before, the writer holds that we shall only be able to avail ourselves of the opportunities for good that the new situation will present, and to steer amidst the difficult rocks that are bound to emerge, if all parties are imbued with the will to bring about a fair settlement of dangerous differences. He finds that the war has worked the miracle of producing that will, leaders of Labour and of Employers having now a firm determination to face and overcome the difficulties. He welcomes the important signs that public opinion, too, is not likely to allow matters to "drift." Indeed, in the interest that the Press and the public have been induced—shall we say compelled?—to take in the matter, there lies the chief hope that a solution will be found. It is admitted that there are enormous difficulties, and that the road "must wind up hill all the way, even to the very end, for the ever-changing values are of such infinite complexity as to render inevitable, possibilities of friction."

As we have repeatedly argued, so Mr. Hichens says, there must be a removal of the suspicion with which both sides still regard each other. The disposition of Labour to suspect Capital is seen in the fear held to-day that the latter will use National Service powers against the former, dragooning workers into the condition of Prussian slavery. On the other hand, employers are inclined to dwell upon the weaknesses that ill-contented Labour has exhibited for years, working adversely against the best interests of national industry, and to suspect that those weaknesses are not repented of. Each side will do better than this if it will honestly face its own shortcomings. Unless this is done, we may drift into the state that always befalls a house divided against itself. What, then, is the urgent need at this juncture? Mr. Hichens describes it as "statesmanship in industry"—both sides taking a wider view of the problems of industry instead of being immersed in their own immediate concerns. There have been many speeches to this effect, but it is doubtful if the disposition to develop, or even to "will," a fair settlement of differences is spreading through the rank and file on both sides as rapidly as one could wish. We have ourselves argued again and again that the best results are likely to follow if each side is effectively organised, so that there may be afforded proper facilities for dealing broadly with industrial questions. We find Mr. Hichens in agreement with us on this point. He instances the engineering industry as a conspicuous case of bad organisation. "Associations of all sorts and kinds exist . . . . but they appear to have been scattered from a pepper pot, for they have no ordered relation to each other or to the industry as a whole." "In fact, the engineering industry resembles a country that has not advanced beyond the tribal system, which makes it an easy prey to outside competition and a source of weakness at home." What he desires to see is one Employers' Federation for the entire industry, including shipbuilding, to deal with the broader aspects of the Labour problem in relation to the whole industry, separate committees dealing with different branches thereof. He believes that a Central Engineering Council is needed, which would be composed of representatives from the Employers' Labour Federation and the various trade associations dealing with special aspects of the engineering industry. This assuredly is what many others also have desired to see, but, so far, have been disappointed. Mr. Hichens views the Federation of British Industries as an organisation which has great possibilities, and he admires the foresight of those who initiated the movement, but he observes with anxiety and fear the tendency of this body to confound its functions as an inter-trade federation with those of an individual trade association, a tendency which he considers, if it is not checked, will lead to disaster. He regards this as the type of organisation that is needed on the employers' side, and wants to see a similar organisation established by Labour, with close relations established between them both. They would be able to hold regular meetings to discuss all questions of trade policy, and learn to understand each other's point of view, without waiting for disputes to arise for settlement. In this way there might be formulated a joint programme of industrial reform based on a practical experience that is denied as a rule to politicians—a constructive policy to which both sides can subscribe. The suggestion that Trade Union representatives should sit on boards of directors is not favoured, as such an arrangement is only likely to be satisfactory if those representatives are elected because of some special business qualification. It will be observed that so far Mr. Hichens does not mention the State. Later, he shows that, in his opinion, the State must hold a "watching brief," and be prepared to settle such differences as Labour and Capital cannot adjust for

themselves. Its real function is to maintain the true balance between conflicting interests—and in the best of all possible worlds there will be conflict, our efforts being designed to keep it down to the minimum—not to follow slavishly the dictates of the majority.

Our readers will have observed that we have been writing along the foregoing lines for some time past. When a man in Mr. Hichens's position continues to appeal for the establishment of organisations suitable for dealing with the situation which will present itself immediately the end of the war is in sight, we are inclined to be impatient for the negotiations and conferences and efforts to that end to have a satisfactory issue. Good work has undoubtedly been done, but apparently the efforts are more or less scattered and incomplete. Are we not still needing something in the way of concentration or co-ordination of our efforts at organisation? Mr. Hodge, the Labour Minister, has delivered speeches suggesting that his Department is finding an improved atmosphere which augurs well for the future; there have been meetings in London, and meetings in Manchester, with an amalgamation of some existing organisations. Everything seems to point to some real progress being made, but the strong combined national organisation has apparently yet to emerge. Without suggesting that the slight falling back of the enemy in France, our successes at Kut, and the desperation of the enemy under the seas, mean that the war is near its conclusion, we may be allowed to express the opinion that the sooner our house is in organised order in readiness for facing industrial problems the better it will be for all.

Scientific Information.

The Committee on Engineering of the General Committee on Research of the American Association for the Advancement of Science has issued an appeal to the industrial research laboratories of the United States, pointing out that in the course of their work many data of great scientific interest must have been arrived at, which for a time, being the exclusive property of the firms concerned, were of commercial value to their owners. Often, however, owing to further progress, such data cease to be valuable to the holders, and are in danger of being lost to the world, and the Committee urges the industries to enrich scientific literature with such facts and data, remarking that some industries have incurred the reproach of absorbing an immense amount of useful information from scientific literature without giving any return in kind, a reproach which could be removed if they would from time to time make public scientific information which has ceased to be of commercial value.

There is undoubtedly a great deal of truth in the Committee's contention, and we cordially commend its suggestion to the notice of our own manufacturing firms, many of whom have accumulated a mass of information for which they no longer have any use, but which is as yet unknown to the world. By so doing, they would benefit our industries in general, and in many cases prevent the useless expenditure of time and money on researches which have been anticipated by themselves. In these anxious times we cannot afford waste in any compartment of our national life; the spirit of co-operation is in the air, and one of the functions of the great trade associations which are springing up ought to be to collect scientific information from their members and to distribute it. The British Association might with advantage follow the example of its American counterpart in this matter, as well as the engineering and other scientific institutions. We must all pull together to secure industrial triumph.

HIGH-PRESSURE CABLE JOINTS.

By S. G.

It is long ago that the stage was arrived at when cable joints (especially H.T. and E.H.T.) had to be made properly to ensure them not coming adrift and causing serious trouble; but although this is so, it is only quite recently that we are informed of a serious breakdown on a German H.T. cable.

Of course, the cause of this recent trouble is attributable to shoddy work, obviously done with a view to cheapness.

We are all apt to rush jobs, therefore British engineers should make a special note of this breakdown, with a view to keeping their reputation up.

Unforeseen accidents sometimes do present themselves, and in this respect it has been known for cables to give trouble due to the solder not having taken properly (the mixture not being correct), the sweated joints, of course, coming adrift.

The shifting of the ground is sometimes the cause of joints coming adrift, as well as being the cause of buckling; and in order to overcome these difficulties, which invariably cause very serious trouble and expense, those concerned should see that the joints are made in such a manner that they will stand up against every difficulty. It can be done; and the following comments may prove useful.

In the first place, the jointing of the copper conductors must be considered. Assuming that the joint is "three-core straight through," the usual method is to sweat the two ends of the conductor into a copper sleeve or ferrule. There is only one advantage in this method of making the joint, and that is simplicity and cheapness.

In order to make a thoroughly good job, the best method for conductors up to, say, 7/14s, is to make a "married" joint.

Now there are two kinds of "married" joints—viz., the real married joint, in which the strands of both cables are opened out, interleaved one with the other, one set of strands twisted "right hand," the other set twisted "left hand," and then the complete joint sweated together. It will readily be seen that a joint made after this fashion is not likely to come adrift. The other kind of so-called married joint is where one cable is merely twisted on to the other; but this is not recommended.

Where a small section "tee" or "branch" connection is taken off a large "main" cable, the strands of the "tee" cable should be divided equally, then one-half twisted around the "main" cable right hand, the other half twisted around left hand, then the complete joint sweated together.

It must be noted that the above comments are only for small cables.

For large cables, sometimes a "scarfed" joint, and sometimes a "butt" joint is adopted, the ends of the cables being sweated into a brass or copper sleeve. This kind of joint is not recommended.

In better-class work the "telescope" joint is preferable, and, if well made, is not likely to give trouble under ordinary working conditions. This type of joint must not be confused with the "married" joint, and the following is the method of making it:—

1. The two ends of the cables to be jointed are made to overlap 1 in., to, say, 3 in., according to the size of the strand.

2. On one of the cables cut a portion off the centre wire (the length depending upon the size of the strand), and the wires of each succeeding layer must be cut so that they are longer than the next layer beneath them.

3. On the other cable the corresponding wires are cut in the opposite manner, that is, the centre wire is long, and each succeeding layer is short, so that when the two sets of strands are brought together they resemble a "plug-and-socket" joint.

4. Bind the joint with 18 or 20 S.W.G. tinned copper binding-wire, then solder the joint thoroughly.

In dealing with this most important subject, it must not be overlooked that we are faced with a mechanical diffi-

culty which has to be overcome. Certainly we all know that the soldering iron and the blow lamp are the jointer's main articles for making a cable joint, and we all recognise a good jointer as an asset. Now, supposing the job were given to a purely mechanical man with instructions that the joint had to be made so that it would not come adrift, you can depend upon it he would see that it was clamped by some means or other.

Purely electrically trained men are apt to forget (perhaps in many cases do not know) that mechanical engineering plays a very important part in electrical engineering; and with regard to the question under consideration, the writer's opinion is that the only sure method of making a good joint with medium and large size cables is by adopting a combined telescope and clamping joint.

The copper fitting for clamping the joint is composed of two halves, top and bottom (both alike); the hole for the cable is drilled to the diameter of the strand with a thin distance piece placed between the two halves, so that when the distance piece is removed the hole is slightly eccentric. The two halves are screwed together tightly on to the two ends of the strands, so that a good grip is ensured. The joint is then sweated. By sweated, I mean a thoroughly

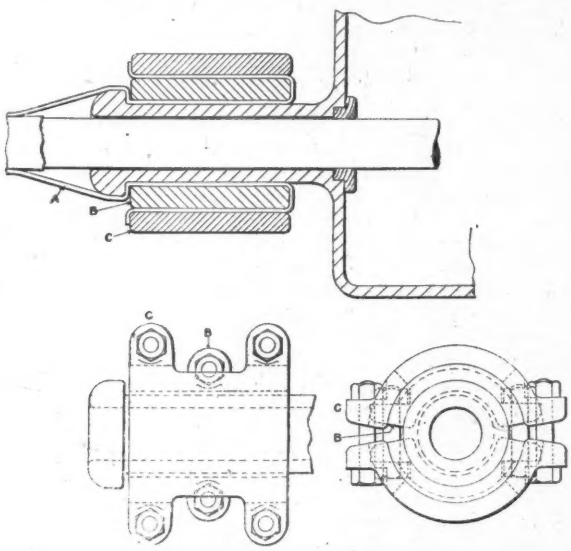

Fig. 1.—Armour Grip for Cable.

good job, not a few pieces of solder dropped on, which is sometimes the case.

It will at once be realised that this combined joint makes a thoroughly efficient mechanical and electrical job, and one in which the possibility of its coming adrift is very remote.

Fittings should be so designed that all sharp corners are avoided.

I think a comment here regarding cables where there may be a likelihood of a pull will be useful, and that is, do not rely upon soldered joints, and do not make "twisted" joints unless it is absolutely necessary.

There are other parts of the joint which have to be taken into consideration; and in discussing this subject, the only joint which will be dealt with is "a straight-through H.T. three-core," the cable being paper insulated, lead covered, and wire or tape armoured.

A difficulty which presents itself when there is a pull on the cable is that the three joints are pulled together and short-circuited. In order to overcome this difficulty, the safest plan is to stagger the joints, tape them up, and insert spreaders or separators, which should be made of either ebonite or porcelain. Some engineers merely stagger the joints; some do not stagger them, but merely tape them up; some merely insert spreaders.

The usual design of spreader is made merely to prevent the joints touching one another. This gets over the trouble of short-circuiting the poles or phases when there is a pull on the cable; but when telescoping or buckling of the joint takes place, then the spreader should be so designed as to prevent the joints from pushing outwards on to the cast-iron box or lead sleeve.

It seems to be the general practice nowadays to reduce the size of the joint box to the very minimum, in order to save cast-iron and compound. This is all right up to a certain point, but the line must be drawn. On an expensive cable scheme the customer expects a box which, above everything else, will be reliable, and in order to make it reliable it must be large enough to accommodate the joint properly. There is still a lot of room in the earth to take joint boxes.

The joints should be staggered and placed a suitable distance from one another, according to the voltage, tightly taped with suitable (well compounded) tape to one and a-half times the thickness of the insulation on the cable, spreaders inserted, and then the whole of the joint enclosed in a lead sleeve of suitable size plumbed on to the end of the cable, then filled with compound, which must be suitable for the voltage at which the cable is working. The pouring holes in the lead sleeve can then be soldered up, after all air has been extracted.

As there is very little, if any, mechanical strain taken up on the lead sheathing (when the cable is armoured), it need only be electrically bonded to the cast-iron box by means of a thin strip of copper tape, soldered to the lead sheathing and screwed to the box.

We now come to the armouring. Sometimes single or double wires are employed, sometimes tape. Whichever is employed, it must be anchored to the box in a thoroughly mechanical manner, so that, whatever strain the cable is subjected to, the armouring will not leave the box. Of course, it cannot be expected that these conditions can be fulfilled without cost, and the writer suggests an armour grip designed somewhat as shown in the diagrams, fig. 1.

As will be seen, a very strong barrel extension or grip is cast on to the end of the box; A is the armouring on the cable; B is the inner clamp, made of malleable iron (in two halves); C is the outer clamp, made of malleable iron (in two halves).

The method of securing the armouring is as follows:—

1. Lay the armouring over the grip.
2. Clamp the armouring between the inner clamps.
3. Bend the armouring over the inner clamps.
4. Clamp the armouring between the outer clamps.

Although this method is a little more expensive and takes up more time than the usual methods employed, it will be found to have the desired effect.

Wire armouring is more easily manipulated than tape armouring, but with a strong hand, a willing heart, and a little patience a good job can be made with tape armouring.

There is a very important point which is often, if not always, overlooked, and that is the settling down of the armouring after it has been gripped for the first time. Although it may be that it is impossible to tighten the bolts and nuts even a fraction of a degree, it will be found that after a few hours the armouring will have settled down, and it will be possible to give the nuts a final tightening up.

PROSPECTS OF THE FRENCH ELECTRICAL INDUSTRY.

There have been, and probably still exist, many misconceptions concerning the development of the French electrical industry prior to the war. The excellence and variety of its products, its power of production, and its rôle in domestic and foreign markets—all have been under-estimated. Contrary to a widely-spread, but quite mistaken, opinion, French electrical manufacturers are capable of supplying a large foreign demand, over and above the domestic requirements of the country. A particularly significant fact, but one which has received little recognition in this country, is that French imports from Germany decreased regularly for years before the war, and were much lower than imports from the same source by most other countries of importance. Even before the war France exported more than she imported in five out of ten divisions into which French statistics divide electrical material, and there can be no doubt that the balance of export will be yet greater in future. In order, however, that development may be as rapid and as extensive as possible, co-operation between manufacturers and other interested

parties must be adopted wherever practicable. "Voluntary union," says M. R. Legonez in the *Revue Generale d'Electricite*, "is the best adaptation to our national character, of the centralisation and co-ordination of individual effort, which have been one of the principal causes of the rapid industrial development of America and Germany."

The capital engaged in the French electrical industry was about £64,000,000 in 1911, and has since increased to £100,000,000 or so at the present day. Thanks to the "most favoured nations" clause inserted in the Treaty of Frankfort, German manufacturers were able to benefit by tariffs so low that it often cost less to import a finished machine than the materials entering into its composition. Yet, in spite of this extraordinary handicap, French manufacturers succeeded in reducing the imports of German electrical material, notwithstanding the increased demand occasioned by central-station development and the ever-extending industrial applications of electricity. In 1910, France stood tenth in the list of importers of German electrical material. In 1912, France occupied the twelfth place, but still imported more than Switzerland; but in 1913 (the last normal year before the war), France imported less than £500,000 worth (*i.e.*, 3.02 per cent. of the total exports) of German electrical material, as against £615,000 worth (3.74 per cent.) imported by Switzerland, and £1,800,000 worth (11 per cent.) imported by Great Britain and the Dominions. The great and growing strength of the French electrical industry before the war is a certain augury of its success in the coming economic struggle.

As regards trade with all countries, the total French imports of electrical material in the last complete year of peace were practically equal to the exports of similar materials. There was an excess of exports in the five classes: Wires and insulated cables, electrical carbon, accumulators, glass insulators, and arc lamps. On the other hand, there was an excess of imports in the five classes: Machines and transformers, electrical apparatus, incandescent lamps, scientific and measuring apparatus, and electrochemical porcelain. In the case of wires and insulated cable, the excess of exports over imports amounts to about £80,000 per annum. The cost of labour has little influence on the cost of the finished product, and the cost of copper, lead, and rubber is practically the same in every country, so that French success in this direction depends entirely on quality. There are several works in the country equipped with modern plant and capable of developing production and export. The electrical carbon industry is very prosperous in France, and covers the manufacture of furnace electrodes, arc lamp carbons, dynamo brushes, and carbon products for use in telephony. International dealings in accumulators are hindered by the fact that this apparatus is very heavy for its value, and is, moreover, relatively fragile.

The manufacture of glass insulators, now used so extensively in telegraphy, is essentially a French industry, and the value of exports (in normal times) is growing rapidly. French arc lamps have established a very high reputation on foreign markets, but, unfortunately for their manufacturers, this system of lighting is daily losing ground. Further advances in design and construction may, however, restore arc lamps to their former position. At the worst, there will hardly be more than a falling off in the rate of increase of their application.

Machines and transformers constitute the most important class of French electrical imports. The excess of imports over exports amounted to about £200,000 per annum before the war (principally from Switzerland and Germany). In respect of traction material France is self-sufficient; indeed, the superiority of French equipment was established by the single-phase loco trials held by the Cie. des chemins de fer du Midi. The best manufacturers of France, Germany, and Switzerland were all represented, but only the French locos passed the very severe tests imposed. After the war, manufacture of electrical machinery, and, indeed, every mechanical industry, will benefit from the modern equipment which has been installed on so extensive a scale for the production of munitions. War work has brought home to everyone the advantages of repetition manufacture and standardised types. Finally, a victorious peace will permit tariffs to be reformed. There is every reason to anticipate greatly increased and more economical production of electrical machinery in France, followed by more numerous and advantageous exports. Rapid progress has been accomplished in respect of electrical apparatus. In 1910 exports had less than 50 per cent. of the value of imports, but in 1913 the ratio had increased to 82 per cent., and will doubtless increase yet further. By force of necessity the manufacture of incandescent lamps, including sockets, caps, and bulbs, has been brought to a high state of development since the beginning of the war, and France will not again become dependent on foreign supplies of essentials in this branch of industry. French scientific and measuring instruments are second to none in design, workmanship, and accuracy, and it is simply a question of increasing production, and lowering prices by specialisation of works and standardisation of types. Similarly, the only reason why 5,000 quintals per annum of electrotechnical porcelain was purchased from Germany before the war was the inadequate production of French works. This deficiency has been made good, works being greatly extended and equipped with the latest machinery and extra-high-tension testing apparatus, so that a large balance of export is certain to be established.

The French electrical industry accomplished far more than is generally realised in meeting foreign competition prior to the war, and it can look with confidence to a period of great development and prosperity in the immediate future.

TRAIN CONTROL ON THE GREAT INDIAN PENINSULA RAILWAY.

In the *Railway Gazette*, Major Hepper gives some particulars of the system of train control used on the Great Indian Peninsula Railway, where it was first introduced in its present form in 1913. The main line between Igatpuri and Manmad was being relaid with the 100-lb. rail which necessitated the working of the traffic temporarily over sections of single line. It was realised that without the special advantages afforded by some system of control it would not be possible to cope with the heavy traffic on that part of the line and at the same time give the engineering department possession of the tracks for relaying. A form of control was therefore put into operation wherein were employed the magneto telephones, in groups of stations, then in use on this section of the Great Indian Peninsula system.

The experience gained on that occasion was so convincing as to the benefits to be derived from train control that the system of moving trains on orders from a central office was extended to other sections of the railway, and there are now 259 route miles of single-tracked, 248 route miles of double-tracked line, and 21 route miles of four-tracked line worked under train control by the magneto telephones.

The system of control by magneto telephones was, however, found to be subject to a strict limitation in regard to the number of stations that could be controlled. The selector telephone system of the Western Electric Co. has, therefore, been adopted, and is gradually being introduced. In this a 200-lb. return copper wire is used, and any station can be called up independently of the other stations.

The Western Electric system is already in use on the section between Bhusawal and Nandgaon, 15¾ miles north of Manmad, a distance of 98 miles, on which there are 31 connections and 58 trains a day, and its extension to Igatpuri has been provided for. Every officer in any way connected with the working of the trains is on the control.

As funds are available for the provision of selector instruments and copper wires it is proposed to concentrate the work, as at Manmad, in central offices.

Each control headquarters has a chief controller, two deputy controllers, three assistant controllers—one for each eight hours—and three recorders—one for each eight hours. In front of the assistant controller there is a diagram showing the siding accommodation at each station. On a table at the side is the train-register kept by the recorder and a tray of plugs for insertion in holes in the diagram to show the positions of trains. The controller has also a graphic chart upon which the working is shown, from which it can be at once seen how the section has been worked, and whether the best use has been made of the facilities available for passing traffic.

In front of the controller is a ringing key case, provided with one key for each point with which he wishes to communicate, each key being clearly labelled to indicate the name of the station it applies to. Inside the case is the selector, composed of a clockwork mechanism controlled by a silent governor, which, by means of a toothed wheel, makes and breaks an electrical contact. The number of teeth and, therefore, of electrical impulses, varies for each point of call.

There is a corresponding toothed wheel in the instrument at each station, and when any key is operated all the wheels on that line are stepped forward in unison. The toothed wheel is operated by a stepping pawl operated by an electro-magnet, the armature of which keeps step with the impulses sent out by the key. A second electro-magnet, arranged to act sluggishly, controls a retaining pawl which prevents the toothed wheel from flying back between the impulses. The magnet is energised immediately the key is operated, and remains energised until the station has been called, when it allows the selector to return to its normal position. The toothed wheel carries control arms, spaced at different positions to correspond with the number of impulses, which are closed in sequence as the selectors step round. The contact at the intervening stations is, however, so short that the trembling bell joined up by the contact has not time to operate. When the wheel reaches the limit set, the contact is closed, the bell at that station is rung, and this is indicated in the controller's office, as the interrupted current of the ringing bell will affect the controller's receiver and he can hear distinctly that the bell is actually ringing.

Should a station wish to speak to the controller, all that is necessary is for the speaker to lift the receiver from the hook and speak into the transmitter, as the telephone sets are all normally in bridge across the pair of telephone wires. In case the controller is not listening on the line, a generator is fitted at stations, and a magneto bell in the controller's office, whereby the controller may be called.

The telephones at the stations are of special construction in order to provide the high-impedance bridge necessary when

so many stations may be simultaneously listening across one pair of lines. They are fitted with high-efficiency induction coils and high-impedance receivers. The instrument is, moreover, provided with a key by means of which, when in one position, the circuit is arranged to give the greatest speaking efficiency, and when in the other position the greatest receiving efficiency.

A battery of dry cells giving 260 volts operates the selectors. In order to avoid sparking at the key contacts the battery is connected to line by means of a telegraph relay. The keys are in a local circuit, including the relay coils, and a small battery; condensers are used to bridge the contacts to reduce the sparking, and retardation coils are inserted to prevent the sudden rush of current which would result from connecting the large battery to line, and which would cause unpleasant noises in the controller's telephone.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Small Municipal Electricity Undertakings and War-time Losses.

In view of the heavy deficits shown by numerous small municipal and urban council undertakings which are situated outside industrial centres, and which rely largely for revenue upon the sale of current for lighting purposes, I am wondering what steps are being taken by the generality of these undertakings in order to cope, or partly cope, with the melancholy prospect now before them.

Between the Scylla of declining output and the Charybdis of rising costs the small station engineer's lot is indeed anything but a happy one.

The larger undertakings are not suffering in the same way that the smaller ones are, as these big stations are sharing in the great industrial boom which the war has brought about, and it is no uncommon thing for some of these larger stations to increase their output for power by millions of units per annum. This, to a great extent, compensates them for loss of revenue due to restricted lighting, and, even apart from this, they are, in the majority of instances, fortunate in having substantial reserve funds from which they can draw to meet any temporary deficit.

The question before a good many small station engineers to-day is: How much of the estimated net loss upon the next 12 months' working ought to be directly provided for by the consumer, and what proportion (if any) by a call upon the local rate?

While, of course, it is only fair that the consumer in these days of abnormal prices should pay a fair price for his current, it is obvious that to ask him to provide for such extra revenue as would completely cover the estimated loss would in the long run do the undertaking far more harm than good.

The consumer himself asks—with a certain amount of truth, I must admit—why should he purchase the undertaking and present it to the town?

The ordinary ratepayer, as distinct from the electric lighting consumer, says: Why should I be called upon to make up losses upon a concern from which I am deriving no benefits? Another point which the ratepayer has in mind is that the great majority of central-station engineers lay it down almost as a law that when profits do accrue from an electrical undertaking they should be ear-marked for renewals and reserve funds, and not given to rate relief. From this he soon builds an argument to the effect that if he is not to benefit from electric lighting profits he ought not to have to make up electric lighting losses.

I am quite aware that in building up a reserve fund the electrical undertaking is providing for abnormal situations such as he is having to face to-day, but I am also aware that a number of these smaller undertakings have never been in a position to inaugurate a reserve fund, and some, indeed, have been for a good many years a regular old man of the sea upon the neck of "Sinbad ratepayer."

To me the question in some respects recalls the old problem of the hen and the egg. Should the consumer pay back to the ratepayer (where, in the past, electrical losses have been met by a call upon the rates) the amount "owing" before proceeding to build up a reserve fund, so that when next the undertaking is in difficulties the ratepayer would again be willing to come to the rescue, or should this very debateable debt be wiped off—leaving the ratepayer with a more or less legitimate grievance?

I realise that the arguments I have put forward, both pro and con, are very elementary ones, but we must not forget that both the consumer and the ratepayer, in a general way, argue in an elementary manner; therefore, it appears to me that a simple ruling on the above points would be preferable to both parties.

Quiz.

February 28th, 1917.

Curious Trouble with Lead-Sheathed Cables.

The trouble experienced by Mr. G. W. Partridge is evidently not electrolytic or chemical, but mechanical.

Without more exact information it is not possible to give a definite opinion, but the cause of the trouble is probably due to expansion and contraction.

The temperature rise of the cables is not stated, but if worked with heavy loading would probably be about 30 deg. F., and the corresponding lineal expansion in a cable 100 yd. long would be: Copper 1 in., lead 1¼ in.

In small cables this expansion would be taken up in the space between the cables and their ducts; in larger and more rigid cables there is no doubt that the expansion pushes the increment of length into the manhole, and I have known movements to and fro of as much as ¾ in. on large lead-covered cables.

These movements are quite sufficient to throw a severe mechanical strain upon the plumbed joint, which is mechanically the weakest point of the lead sheathing. Again, the different rates of expansion of copper and lead for the same temperature rise do not improve matters, and will certainly cause further strains owing to larger increments of length of the lead over those of the copper and paper; in fact, the whole problem of protecting cables from expansion troubles has not received any adequate consideration so far as I know.

The trouble points to the advantage to be derived from an insulated pilot system just under the lead, giving warning of the failure of the lead sheathing.

Leeds, *February 27th*, 1917. **J. Shepherd.**

The Inspection of Munitions.

Judging from the letter in this week's REVIEW, referring to my short article on the above subject, and signed by "Albion," I am both ignorant and foolish. I am none the less rather amused, and not downhearted at the strictures of the writer. The cap fits, evidently. Now, I can easily ignore the abuse, and do not write this as an occasion for retaliation in the same kind. Also, the question of my experience and the "shop foreman" theory I leave to the Editors of the REVIEW, who saw fit to publish my article.

"Albion" complains that I have only two minor complaints to make. He might remember that wise people do not say all they know, and two small straws can show the direction of the wind. Will he contradict the truth of all or any of the following assertions?

1. Material has been rejected by Government inspectors, and, following manufacturers' protests, the rejections have been cancelled and the goods accepted.

2. Inspectors have been known to admit that they could not put a practical test on the goods they were sent to inspect.

3. Resident examiners have been sent from London to a works, scores of miles away, to stay on the works. In a few days they were ordered back, thus wasting money on railway and hotel expenses unnecessarily.

4. Scores of forms are being used as described in my article, in a manner which is wholly unnecessary, and which shows that the staff at headquarters do not know the nature of the material concerned.

5. Officers are using motors and petrol in a way which no business house would countenance on work which could be centralised.

If "Albion" can say "No" or "Yes" in a direct manner to these queries, your readers will be able to form their own conclusions as to who should be saddled with the word in question, a word which was used in a general manner in the original article, but which "Albion" very perfidiously ascribes to

March 3rd, 1917. **Commercial.**

Fuse Failures.

When I wrote my letter published, by your courtesy, in your issue of February 16th, I was not unmindful of the point raised by Mr. Baynes as to the advisability, or otherwise, of using concrete boxes in certain special cases for sealed house services. I desired to convey, however, that for commercial purposes the fuse referred to, of German origin, is under all conditions less satisfactory than the fuse of British origin, as designed, whether fixed upon an open switchboard, enclosed in earthenware, papier maché, concrete, or an earthed iron case. There is no wonderful secret or hidden mystery in either form of fuse; the success of both depends upon the fundamental necessity of excluding air from the fuse link. It is comforting to realise that the wily Teuton, with commercial penetration to achieve low "first cost," has adopted a narrow design, which necessarily limits the fuse capacity, and which is very dangerous when misused. The Britisher has beaten him from the start upon all points.

A brief summary of useful points given below may interest the student of fuse failures:—

1. Alternating current, and non-inductive direct-current, circuits present no fusing difficulties.

2. Millions of earthed iron cases are installed to-day, and when the Home Office recommendations have been followed, the chance of breakdown is negligible, if not non-existent.

3. All cartridge fuses should be so designed that in case of shortage, the length of break between the terminals should be such as to provide "ample clearances" under normal "open fuse" conditions. Standard minimum fuse lengths should be adopted for this purpose, then the risk of abuse is reduced to a minimum.

4. All iron cases should be so constructed that an open fuse under average normal conditions will clear itself without damage.

5. The personal element cannot be entirely eradicated, and the user should be educated to avoid the "abuse" of fuses.

In conclusion, I would like to say that I hope Mr. Baynes will join the members of the Panel engaged upon the standardisation of fuses. He would be sure of a hearty welcome.

Berry, Skinner & Co.
HERBERT H. BERRY.

London, W., *March 6th*, 1917.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Readers are invited to submit particulars of new or improved devices and apparatus, which will be published if considered of sufficient interest.

A Useful Compound Thermo-Element.

THE accompanying illustration shows the construction of a useful compound thermo-element permitting temperature measurements to be made simultaneously at two points A and B. The couple terminating at A is composed of platinum and platinum-rhodium wires, and to the other ends of the latter there are connected respectively a silver wire and a constantan-silver thermo-couple. The three branches thus obtained are connected through terminals I, II, III, to two galvanometers A,' B'. Such a combination has many useful applications, the particular one in which it is described by Hilliger in the *Zeits. des Vereines deutscher Ingenieure* being

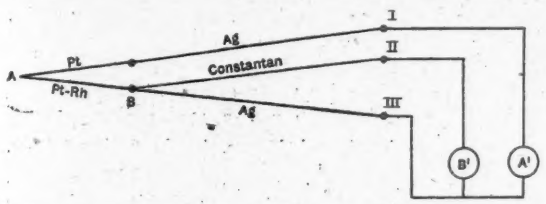

FIG. 1.—ARRANGEMENT OF COMPOUND THERMO-ELEMENT.

to the measurement of flue gas temperatures at the front and back of a section of flame-tube filled with pieces of refractory material on the Bonecourt system. The compound thermo-element is cheaper and more compact than two separate couples, and for the above purpose the platinum couple was made 60 cm. (24 in.) long, and the silver-constantan couple was made 160 cm. (63 in.) long. The whole was mounted in a steel tube of 8 mm. internal and 12 mm. external diameter, which was so small as not to disturb appreciably gas flow in the flame-tube under observation. The high temperature end of the compound instrument was protected by a quartz sheathing. The couples being calibrated separately for a cold-junction temperature of, say, 20 deg. C., the reading of the galvanometer B', in conjunction with the calibration temperature, gives the temperature of B and, this being known, the reading of galvanometer A' (which measures the temperature difference between A and B), permits the temperature of A to be deduced. In the special application noted above, the couple A measured the temperature of flue gases at the entrance to a flame-tube, whilst B measured the temperature at the back of the refractory "filling" in the latter.

Plastic Solder.

We have received from MR. A. P. BEVAN, of Tavistock, a sample of "plastic solder" which he has invented. It is used like ordinary solder, but differs from it in that it passes from the solid to the liquid state through a plastic stage, in which condition it can be worked like putty. It becomes liquid at a dull red heat. We have used some of the sample, and find it quite handy and effective, and very easy to manage, as it does not tend to run off an inclined surface.

Marconi Vacuum Ampere Gauge.

In the *Wireless World* for February is given an account of a simple and ingenious instrument for measuring small currents, both D.C. and A.C. The instrument is designed primarily as a maximum-current gauge to indicate the condition of syntony in wireless circuits; it may also be employed as a substitute for a thermo-junction and galvanometer combination in the measurement of wave-lengths and decrement. The principle involved is that of the bifilar suspension, one pair of the filament ends being fixed, and the other pair attached to a pivoted arm, the rotation of which is controlled by a spring acting against the tension of the filaments. When a current passes through the filaments, heating them and causing them to elongate, the arm takes up a new position, and the angular displacement, as indicated on the scale, is a measure of the current.

The movement is enclosed in a glass bulb exhausted of air. The sensitiveness is thus greatly increased, and the movement protected against damage and preserved from dust or corrosion.

The accompanying fig. 2 shows the construction of the device, which is made up after the fashion of an incandescent lamp, with either a bayonet socket or Edison screw, as preferred. Other forms are made with terminal caps at both ends. The variation in zero, which usually characterises thermal instruments, is said to be negligible in this type, and the movement is very dead-beat. The instrument may be used either as a low-reading voltmeter or ammeter, or as a shunted ammeter, having a normal resistance of about 12 ohms; a high-resistance pattern has a resistance of 30 ohms. These gauges have maximum readings of 0·11 and 0·035 ampere, 1·44 and 1·25 volts, respectively, and read down to 0·02 and 0·007 ampere; the cross-arm seen in the figure carries two pointers, for reading amperes and volts respectively.

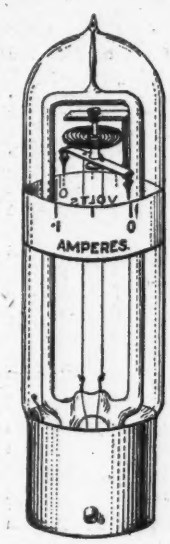

FIG. 2.—MARCONI VACUUM AMPERE GAUGE.

With a wavemeter using the new vacuum gauge the wave-length of the primary circuit of a 1½-KW. set can quite easily be read when the wavemeter is held with the plane of its inductance coils parallel to that of the primary of the oscillation transformer at a distance of 2 or 3 ft. The noise of the spark, which often hinders the reading of a wavemeter by means of a crystal and telephones, in the case of the vacuum gauge gives no trouble, as the variable condenser has simply to be rotated until the pointer of the gauge gives the maximum reading. In this way circuits can be tuned rapidly as well as accurately.

In addition to the type of instrument described, a range of ammeters has been designed for all capacities between 50 and 500 amperes. These instruments, while following the general design of the smaller gauges already described, differ from them considerably in detail. In the large meters the suspension filaments carry no current.

A type of vacuum instrument for direct insertion in the aerial circuit is also being developed.

Pouring Acid from Carboys Without Spattering.

Serious damage is frequently caused by the spattering of acid when pouring acids from the carboys in which they are usually shipped. The contents of a carboy may be poured in a smooth, even stream if a bent glass tube is used as shown in the accompanying sketch, fig. 3. The tube should be ¾ or ½ in. inside diameter, and may be bent by slowly warming a section about 6 in. long over a Bunsen gas flame; as soon as the glass has softened, the bend can be made. A hook made of stiff, rubber-insulated wire is bent around the tube to permit of hooking it over the mouth of the carboy, so that both hands are left free to tip the carboy carefully and to direct the stream into the jar that is to receive the acid.

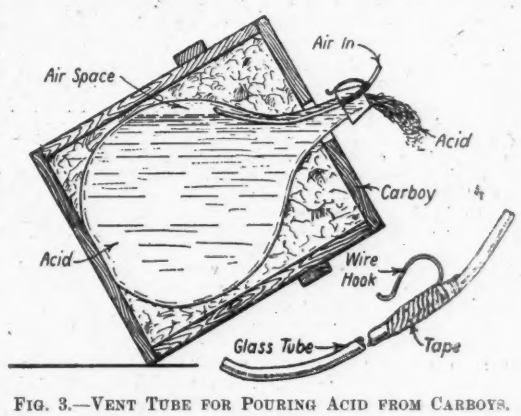

FIG. 3.—VENT TUBE FOR POURING ACID FROM CARBOYS.

The tube lets air enter the carboy so as to replace the acid flowing out, and thus allows a uniform, steady stream to flow without spattering.

If a wire hook is made as shown, it must be thoroughly taped with rubber tape to prevent the acid from being contaminated by solution of the metal of the wire hook. A good inclinator should be used where carboys are to be handled frequently; it makes for safety, and also enables a single man to pour out their contents.—L. M. Dellinger, in the *Electrical Review and Western Electrician.*

D

WAR ITEMS.

Controlled Works.—The number of establishments controlled by the Ministry of Munitions is now 4,770.

Trading with the Enemy.—The "London Gazette" for March 2nd contains further lists of persons and bodies with whom trading is prohibited in various countries.

Entertaining the Wounded.—The "Times" states that the London staff of the Western Union Telegraph Cable System entertained 125 wounded soldiers from a number of hospitals on Saturday afternoon at the Savoy Hotel.

To be Wound Up.—The Board of Trade has ordered the following to be wound up:—

Mea Magneto Co., Ltd., 3, Stephen Street, London, W., dealers in magnetos, magneto parts, and accessories. Controller: C. R. Beeby, 66, Basinghall Street, E.C.

Women Electrical Workers.—It is announced in the daily Press that Messrs. Rawlings Bros., Ltd., of Gloucester Road, South Kensington, are prepared to give free instruction in electrical work to young women who wish to replace men for national service.

Imports from Neutral Countries.—The Board of Trade announces that on and after April 1st no goods of neutral manufacture of which more than 5 per cent. of the cost to the manufacturer is due to materials and labour of enemy origin, will be admitted into the United Kingdom except under licence.

Munitions and Trade.—According to announcements in the daily Press, Mr. Edgar Jones, M.P., has been appointed by the Minister of Munitions as Controller of the Priority Department. A new priority advisory committee, under the chairmanship of Mr. J. Wormald, consisting of Mr. Kenneth Chance, Mr. Alexander Walker, and Mr. Henry Woodall, has been appointed to advise the Controller and the Minister as to the effect of any restrictive Orders of the Ministry of Munitions upon trade, with a view to causing the minimum of hardship.

Paper Supplies and Catalogues.—Under an Order issued last week it is provided that as from to-morrow, March 10th, the sending to the public of any tradesman's catalogue, price list, or advertising circular, through the post or otherwise, is forbidden, unless a request has been made in writing for the delivery thereof. The sending of catalogues or price lists by traders to traders, for the purpose of their trade, or to persons abroad, is, however, to be permitted. Licences may be issued by the Board of Trade dispensing with the application of the Order to any person or thing, or any class of persons or things. Posters making announcements with respect to goods offered for sale by a retailer may only be displayed on the premises where they are so offered for sale. No paper poster may exceed 600 sq. in. superficial measurement.

Exemption Applications.—At Doncaster, the case of a switchboard attendant from the Mexborough & Swinton Tramways Co. was appealed against, both by the company and the Military Representative. Applicant had been exempted by a local tribunal until April 16th. He was 21 years of age, passed for general service, and earning 30s. a week. It was pleaded that it was necessary to keep a competent man at the main switchboard, but, in answer to the Military Representative, it was said that that work was now being done by women at sub-stations, but not at power stations. It would take 12 months to train a man for the power-station work. The Military Representative stated that the man was put back 10 groups 12 months ago, and he thought they had had sufficient time to find an efficient substitute. The Tribunal, however, dismissed both appeals.

Gillingham (Kent) Town Council appealed for C. W. Warby (28), fitter's assistant at the electric light works, passed in Class C 1. The electrical engineer (Mr. A. D. Chalmers) claimed that Warby was, through his occupation in a public utility department, in a reserved occupation. Coun. Freathy said that Class C 1 men were wanted as substitutes, and Warby could be replaced. With this object in view, the appeal was respited for a month.

At Stratford-on-Avon, an appeal was made by J. Clifford (27), in C 1, an electrical turbine worker engaged with the British Thomson-Houston Co., Ltd., at Rugby. It was urged that in view of his low category appellant should be allowed to remain at his present work rather than be taken to perform such military service as a C 1 man could do. The works manager of the B.T.H. Co. wrote suggesting that appellant would be doing a greater service to the nation by resuming duty at the works than he would by entering the Army. It transpired that appellant had been with the company from February 9th, 1915, until he received his calling-up papers on February 15th last, and that his badge was taken away a few weeks before he left. The Military Representative suggested that if the B.T.H. Co. could find a Class A man to be released then appellant might be allowed to remain; otherwise he ought to go into the Army. The Tribunal allowed two weeks for appellant to find work of national importance.

On the appeal of the Military, the conditional exemption granted to Mr. C. H. Fancy (26), managing engineer-in-charge for the Harold Wood Electric Supply Co., Ltd., has been withdrawn by the Romford Rural Tribunal, and a short period of temporary exemption substituted.

At Orsett (Essex), the Stepney Board of Guardians appealed for exemption for the electrical engineer at their Stafford Homes, who is 31, and was engaged in July, 1916, on the understanding that he was ineligible for military service. He was in Class B 2, and the only skilled mechanic at the institution. Mr. Brooks (Military Representative) expressed the opinion that time must be allowed for another man; clearly the institution could not be left without an electrical engineer of some sort. He would be useful to the Army, and he would not object to two months to enable a successor to be found. This term was conceded.

At Barnstaple, the Corporation electricity department appealed for the retention of M. Andrew (18), in Class B 1, a premium pupil in electrical engineering. The manager of the works, Mr. Hadfield, stated that they had become greatly understaffed, and the work was only being continued with difficulty. The Tribunal allowed exemption until September 1st, on Andrew undertaking a share of the night work, the Chairman intimating that they were impressed by the fact that all the brothers of Andrew, five in number, were serving.

Before the Hants. Appeal Court, Mr. Robson, tramways manager, Southampton, applied for exemption for 25 members of his staff. In each case three months were granted, with leave to appeal again.

Exemption held by E. Rothwell (32), electrical engineer at the Rochdale Board of Guardians' institution, in Class A, was opposed by the Military Representative. The Clerk to the Guardians, Mr. R. A. Leach, stated that they had received an urgent request to provide increased accommodation at the workhouse for wounded soldiers. Mr. Rothwell was an X-ray expert, and was occupied daily on that work. The appeal was refused, and the exemption confirmed.

At Bermondsey, Mr. W. J. Heenan, borough electrical engineer, applied for the exemption of a topman at the electricity and destructor works. He stated that it was impossible to obtain a man to replace him. A member of the Tribunal said they had been taking men from trades like this who could not be replaced, as there were no men left. He was granted three months' exemption.

At St. Annes'-on-the-Sea, the Tribunal heard the case of a man of 26, passed for general service, who is employed by a contractor in carting coal to the St. Anne's electricity works. The Clerk to the Council said they had endeavoured to get the coal carted by steam wagon, but were unsuccessful, and the Chairman said there were 24 wagons of coal waiting to be unloaded, and the delay was a serious matter. The case was suspended for a month, with a view to making other arrangements.

At the Shoreditch Tribunal, Messrs. Anselm Odling & Sons, Ltd., Crown Wharf, New North Road, marble merchants, appealed for W. Jefferies, aged 37, single, an electric crane driver, for the third time. Mr. Odling said this electric crane was up on a high scaffolding or carrier-way, which ran the crane out, and lifted the marble out of barges in the canal. First of all, an electrical crane wanted understanding, and then, again, it was most necessary to have a man of splendid nerve. Old men could not stand the height and the work, and had had to leave it. It was a 10-H.P. electrical crane, capable of lifting 10 tons. The Tribunal granted four months, conditional on joining the V.T.C.

Before the Chertsey Rural Tribunal, on February 24th, the Military again applied for the withdrawal of exemption granted to Mr. G. W. R. Howard (37), of Pyrford, inspecting engineer to the Tudor Accumulator Co., Ltd., and responsible for the proper maintenance of the firm's storage batteries at military camps, forts, hospital, and railway and munition works throughout the South of England. A further three months' exemption was allowed.

Before the Surrey Appeal Court, at Croydon, on February 24th, Mr. B. R. Pearce appealed for R. Anderson (34), in Class B 2. He said that he was manufacturing electric batteries formerly made by German firms, and Anderson had found out the secret of how they were made. Two months were conceded.

Nevada Transmission Storm Damage.—The *Journal of Electricity*, in a recent issue, illustrated the effects of sleet storms on transmission lines in the Sierra Nevada Mountains. In December last unprecedented storms of snow and sleet occurred; the sleet on the wires formed a frozen cylinder weighing 3 lb. or more per foot and as much as 6 in. in diameter, and the dead weight, together with a 50-mile wind, caused a number of towers to collapse. The towers carried two circuits with a 660-ft. span, and were designed with a factor of safety of 2, to withstand the weight of ½ in. ice coating and a wind of 75 miles an hour. No two towers failed in the same place; it is considered cheaper to repair the damage than to construct for such unusual strains.

Coal Advisory Board.—An Advisory Board has been appointed to assist the Controller of Coal Mines on general questions of policy; it comprises five representatives of coal owners and five of the miners.

ELECTRIC LIGHTING IN FRANCE.

As might be expected would be the case, the electric lighting companies in France which are dependent upon steam generating plant were very unfavourably placed during the year 1916, owing to the very high cost of coal and the difficulty of obtaining adequate supplies, and to the dearness of other raw materials. As a consequence, many companies were compelled to reduce their rate of dividend as compared with that of the preceding year, whilst no distribution whatever has been made in some cases. An exception to this state of affairs, however, is afforded by the Société d'Electricité de Paris, which is a bulk supply company, and furnishes energy to a small number of customers, particularly the Metropolitan Railway, the Nord Sud Railway, the Tramways de Paris, the Compagnie des Omnibus, and certain distributing companies, such as the Société d'Eclairage et de Force, &c.

The Société d'Electricité de Paris has an interesting form of contract with its customers. The price for energy is based upon the average price of coal in the current year for the time being, but as the latter cannot be definitely ascertained until after the end of December the price charged to customers is provisionally arranged on the coal price in the previous year, the final adjustment of accounts only being made in the following year. It thus happens that when the price of coal in any one year becomes enhanced, the supply company plays the part of banker to its customers, whereas the clients fulfil this part towards the company if the quotations for coal fall during the year. Under normal conditions the coal prices only vary within certain limits, as, for instance, from 3 fcs. to 4 fcs. per ton. As the company consumes 200,000 tons of coal per annum variations of these amounts only represent from £24,000 to £32,000, the cost of which can be defrayed out of floating capital. But when the price is advanced by 300 per cent., or £2 8s. per ton—as took place in 1916—the sum involved rises to £480,000, and no company with an ordinary share capital of £1,000,000 could have floating funds available to meet the requirements of the case. Under the circumstances, the company in question has endeavoured to make arrangements with its customers for payment in advance, but these efforts have only been partially successful, and the problem continues to be a heavy financial burden.

M. Daniel Berthelot, Chairman of the Société, drew attention to another aspect of the coal problem at the recent annual meeting of the shareholders. Apart from the fact that French coal prices have been fixed by the Government, permits have to be obtained by all companies or firms for the importation of English coal, and as this was fixed by the British Government at not exceeding 2,000,000 tons per month, a crisis has arisen in regard to supplies, and is preventing the formation of stocks at the electricity works, as in former years. Nevertheless, the company referred to has been able to increase its output, and to render assistance in recent months to other companies in Paris which are also working for the national defence. The total sales in 1915-16 amounted to 116,824,000 KW.-hours, as compared with 85,564,000 KW.-hours in 1914-15, and 145,300,000 KW.-hours in 1913-14, which was the year of maximum turnover. As showing the development in recent times, the Chairman mentioned that sales from July 1st to November 30th, 1916, reached 60,570,000 KW.-hours whereas in the corresponding period of 1915 they were 45,275,000 KW.-hours, and only 28,711,000 KW.-hours in the equivalent term in 1914. The dividend is at the rate of 8 per cent., as in 1914-15, and is the same as in the company's most prosperous years prior to the war. On the other hand, the average selling price realised per KW.-hour has declined of late years, owing to the competition of other and more recently established works, and the consequent necessity for accepting lower prices in connection with the renewal of old agreements or the conclusion of new contracts.

REFILLABLE FUSES.

THE subject of the design of fuses, which for some time has figured prominently in our pages, has recently attracted attention also in the United States, where the Bureau of Standards has been acting as referee between the Underwriters' Labaratories (Inc.), of Chicago, and the Economy Fuse and Manufacturing Co., of the same city. The question at issue was as follows :—"Has it been shown that the use of the fuses manufactured by the Economy Fuse and Manufacturing Co. results in no greater fire or accident-hazard than the use of other cartridge-enclosed fuses at present listed as standard by Underwriters' Laboratories (Inc.)?"

While the particular make of fuse whose merits were under investigation may have no intrinsic interest for us, the broad question at issue is one which appeals to all supply engineers and contractors—namely, whether the user of a fuse should be aided or hindered in renewing his fusible cut-outs by means of wire. A considerable amount of evidence was submitted to the Bureau by both parties, and by companies manufacturing "approved" cartridge fuses, and the Bureau also carried out a large number of tests under various conditions, to determine the relative performance on heavy overloads of new and refilled fuses, and the effect on such fuses of protracted service under normal conditions.

Apparently the performance of the Economy 250-volt fuses was generally satisfactory, and the real reason why the Underwriters' Laboratories withheld approval was that the Electrical Committee of the National Fire Protection Association held that fuses designed to be readily refilled by the user should not be approved, because of the greater probability of misuse than in the case of fuses difficult to refill. It may be noted, however, that the Economy Co. submitted samples of the latter for the purpose of demonstrating the *ease* with which they could be refilled by the user, in spite of the intentions of the designer; the Bureau, in its Report,* remarks that the point was quite clearly established, and that the investigations of its own inspectors show that replacement both with the proper fuse elements, and with improper elements, is actually done to a considerable extent.

It is unfortunate that no drawings are given showing the construction of the various fuses that were tested, but from the references in the text they all appear to have been cartridge-type fuses, with fibre casings, some at least having copper ends, and some kind of powder as a filler (an older type of the Economy fuse contained powdered filler, but not the type at present manufactured). Some or all of the patterns had indicators to show when they had been blown. Tests were made in the laboratories of the Bureau of Standards, under "very mild short-circuit conditions" (with currents limited to 800, 600, and 400 amperes, the fuses being rated at 30 amperes 250 volts), on the Economy fuses and six approved makes; further tests were made at one of the Boston Edison Co.'s power plants with limiting currents of 10,000 and 5,500 amperes, and various inductances in circuit, and at Chicago 600-volt fuses were tested under somewhat similar conditions. In some cases the Economy fuse was better, in others worse, than its rivals. Tests on "aged" fuses—*i.e.*, fuses which had carried their rated current for a considerable time—gave inconclusive results, but the deterioration was markedly greater with unfilled Economy fuses than in the case of fuses using powdered filler, which did not reach so high a temperature. Most of the tests were made on single fuses; when two fuses were used in series, the usual condition in practice, the operation of Economy fuses was entirely satisfactory, though the limiting current was 10,000 amperes. In the course of the investigation, experiments were made which showed that, under service conditions, short-circuit currents of 10,000 amperes or more could very frequently be obtained over a considerable area near a large modern power plant, and values ten times as great were observed. One make of fuse which had received approval was found to be decidedly below the standard set by the Underwriters' Laboratories.

In the course of the investigations, it was found that abuse of approved fuses took a great variety of forms, such as bridging with heavy wire or nails, filling the fuse cartridge with melted solder, &c. On one inspection trip an engineer of the Bureau found one in seven of 379 approved enclosed fuses to be improperly refilled, but on other occasions the tendency to abuse such fuses was found to be relatively small. Small shops make a regular business of refilling approved fuses, and often do it as badly as when the user attempts to do it himself. On the other hand, the evidence indicates that there is less tendency to abuse the Economy fuse than in the case of standard patterns, a fact which is attributed to the relative ease with which the former can be refilled with the proper elements; and while individual Economy fuses have failed in various ways, there is no evidence that the use of such fuses has increased the fire hazard. But the deterioration due to repeated blowing of the fuse elements in the same casing is regarded as an undesirable feature, and the Bureau considers that the approval of the present type of Economy fuse for unrestricted use would result in a lowering of the standard of fuse performance, and

* Technologic Papers of the Bureau of Standards, No. 74.

might introduce hazards of uncertain value. The actual finding of the Bureau, as referee, is somewhat hesitating and inconclusive; it recommends that the Economy fuses be not approved at present for general use on the same basis as fuses at present listed as standard, but that their use be permitted under conditions where their performance can be observed, until sufficient experience has been gained to justify an unqualified verdict.

It may be mentioned that this was the first instance in which the Bureau of Standards was invited to act as referee, and the Director, Dr. S. W. Stratton, in opening the proceedings, said that it marked an important period in the history of that Institution, indicating also a very important change that was going on all over the country—namely, to break away from costly and senseless legal fights, and to settle questions upon the basis of fact alone. The evidence is reported at great length, and contains much interesting matter; full particulars of the Bureau's tests are also given, together with numerous oscillograms showing the relations of current, voltage, and time. In the absence of details of the construction of the fuses, however, we think no advantage would be gained by reproducing these.

LEGAL.

The B.T.H. Trade Mark.

In the Chancery Division, on February 28th, Mr. Justice Astbury heard an appeal by the British Thomson-Houston Co., Ltd., from the decision of the Registrar of Trade Marks, refusing to register as a trade mark the letters "B.T.H." inside a circle with scrolls, which the company had used long and extensively to distinguish their goods. The Registrar's grounds for refusal were that initials were not capable of registration as a trade mark, and that a circle, even with scrolls, was too common to be distinctive of any particular class of goods with which it was desired to connect them.

The case was argued on behalf of the company by Mr. J. Hunter Gray, and the Registrar was represented by Mr. Austen Cartmell.

Giving judgment, his Lordship said that the company had used the mark continuously and extensively since 1905 as a trade mark, and they said it had become distinctive of their goods. The question was whether it was distinctive within the meaning of the Act; and he had no alternative but to hold that it was, in view of the evidence of long and extensive use. The applicants were, therefore, entitled to have the registration of the mark proceeded with, and he directed the Registrar so to do.

London United Tramways, Ltd., *v.* L.C.C.

In the King's Bench Division on Monday, before a Divisional Court composed of Justices Bray and Horridge, this arbitration case, which is a motion by the London County Council to set aside an award, was mentioned.

Mr. Morton, K.C., said that he wished to apply to their Lordships, with the consent of all parties, that the case should stand over for a fortnight. He said that there was a very large amount of money in dispute. The matter had been stated in the form of several special cases, and one particular item in the money involved was that relative to the Chiswick power house. The London County Council were asking that that part of the award should be set aside on the ground that there had been an excess of jurisdiction. There had been negotiations going on over a long period between the parties with a view to arriving at a settlement of the matters that were in dispute. Apart from the item that Counsel had referred to, there were other sums in dispute relating to the purchase of these tramways within the County of London, and if the adjournment was granted it was hoped that a complete settlement might be arrived at.

Their Lordships assented to the adjournment, the case not to come into the list before a fortnight from the date of the application.

Electrical Installation at a Theatre. Alleged Breach of Contract.

Mr. Edward Pollock, High Courts Official Referee, on Thursday, March 1st, again resumed the hearing of this action, in which Vaughan & Co., Ltd., electrical engineers, of Cross Street, Islington, sought to recover from the Golder's Green Amusement and Development Co., of Duke Street, St. James', the balance of charges for putting in an electrical installation at the defendants' new theatre of varieties at Golder's Green. They also claimed damages for breach of contract.

Mr. Hewitt, consulting electrical engineer, gave further evidence in support of the plaintiffs' case

Cross-examined on the specification, Witness said that carbon lamps were sometimes used for coloured lights, but the advantage would be a very small percentage. The specification provided for cables which were in excess of those necessary for the work they had to do.

Supposing, instead of continuing to take the supply from the supply company, the theatre at any time had determined to put in its own supply, would you prefer the cables as required by the specification or the cables as put in?—Taking the installation as a whole, the cables as put in.

Re-examined by Mr. Copping: As to the sectional area of the cables and the cost of the extra cables, he said he had gone thoroughly through the specification, and, in his opinion, it was originally based on 100 volts and then altered to 240, and the wiring had to be altered to meet the change. It was carried out in accordance with the 240 volts.

This evidence closed the case for the plaintiffs.

Mr. Ernest Pollock, K.C., opening the case for the defence, said that the contract under which the claim was made was contained in two letters—a letter from the plaintiffs submitting a tender, and a reply from the defendants accepting it. The plaintiffs offered to fit up the installation at the defendants' theatre of varieties for the sum of £1,700. They said that they duly equipped the theatre and carried out extra work outside the contract. They admitted having received on account £1,650, and said that they had sold and delivered goods to the defendants to the amount of £367 2s. 9d. Defendants did not dispute the contract, but said that the plaintiffs had not done the work properly, and had not completed it. As to the extras, he said that a written order was a condition precedent to any extra work. The defendants further said that the payments made had not been paid on account, but that they had been made, upon the architect's certificate, in full. The plaintiffs, in their letter of September 15th, 1913, had undertaken to do the whole of the work for £1,700; but the plaintiffs now said that they (defendants) interfered with the consulting engineer (Mr. Mitchell), and that in consequence of that they were discharged from doing the work strictly in accordance with the specification. He (counsel) agreed, to a large extent, with the views of the other side as to the effect of the alterations. They could not supplant a person named in the contract by another person not named in the contract. So far, there had been a breach of the terms of the contract, and the plaintiffs could sue for *quantum meruit* or for the contract price, deducting what it would have cost to finish the work. The plaintiffs had elected to sue upon the contract, with a claim for extra work, and in suing upon the contract they were still liable to fulfil the conditions precedent and produce the orders for the extras, because there was no power to waive the conditions. In respect of a number of the items claimed for, no orders in writing had been produced. After the evidence that had been given, it was quite clear that the plaintiffs had put aside the specification altogether.

Evidence was called, when the case was continued on Friday, in support of the defendants' case, expert witnesses giving their opinion as to the manner in which the work had been carried out, and the cost of alteration where that work, as alleged, was not in accordance with the specifications. One of the witnesses stated that the cost of altering the work now would be much more than the amount of saving to the contractor had been. He estimated the total amount necessary to make good all the defects, and put the installation in a condition as required by the specification and contract, at about £1,169. He went into minute details of each item of the suggested necessary work, but admitted that he had based his estimates upon an examination made three months ago, after the whole installation had been in use for a period of three years, and he had heard of no mishap occurring during that time.

Mr. Ernest Pollock, K.C., counsel for the defendants, on the case being resumed on Monday, March 5th, urged that even though the defendants would not be in a position to sue the old company for their counterclaim, the figures should be determined.

Mr. Copping, addressing the Referee upon the plaintiffs' case, said that on Boxing Day, 1913, the plaintiffs had executed a considerable amount of work for the defendants, work which enabled them to have their theatre opened on that day with the light on. A fair price for the work and labour done on the defendants' premises, and goods supplied, amounted, according to the evidence, to £3,014 2s. 9d. In respect of that total the defendants had paid £1,650, leaving £1,364 2s. 9d. for work done and goods supplied, for which the plaintiffs had received no payment at all. On the contrary, it was suggested that the plaintiffs were indebted to the defendants in the sum of £632 2s. 3d. Although they had had the installation put in on the most favourable figures that could be put forward by any of the witnesses for the defence, there was an unpaid balance of over £800. The contract between the parties, he argued, was to carry out the installation to the satisfaction of the consulting engineer and architect mentioned in the contract. The throwing-over of the consulting engineer and architect was an abandonment of their contract, and the plaintiffs were entitled under the circumstances to recover on a *quantum meruit* for work done. But he still submitted that the work had been done in accordance with the contract.

The Official Referee reserved judgment, as there were points of law and of fact which it was necessary for him to consider.

British Thomson-Houston Co., Ltd., *v.* Duram, Ltd.

This case came before the Appeal Court on Tuesday, on the appeal of the plaintiffs from a judgment of Mr. Justice Astbury in favour of defendants. The case is proceeding.

Excess Profits Duty.—The Board of Referees has considered applications from the undermentioned companies for an increase of statutory percentage, with the results stated:—

Shanghai Electric Construction Co., Ltd., and Hankow Light and Power Co., Ltd.—Percentage increased to 9 per cent. in case of trade or business carried on or owned by a company or other corporate body, and to 10 per cent. in the case of any other trade or business.

TRADE STATISTICS OF SWITZERLAND.

IMPORTS.

The following figures of the imports of electrical and similar goods into Switzerland in the year 1915 are taken from the recently-issued trade statistics; the figures for 1914 are added for purposes of comparison, and notes of increases or decreases are given.

	1914. Francs.	1915. Francs.	Inc. or dec. Francs.
Electric cable not insulated.—			
From Germany	19,000	2,000	– 17,000
,, France	1,000	—	– 1,000
,, Other countries ...	200	—	– 200
Total	20,200	2,000	– 18,200
Electric cable insulated with rubber or paper.—			
From Germany	90,000	5,000	– 85,000
,, Great Britain ...	—	1,000	+ 1,000
,, France	20,000	4,000	– 16,000
,, Other countries ...	3,000	142,000*	+ 139,000
Total	113,000	152,000	+ 39,000
* Italy.			
Cable ditto covered with lead.—			
From Germany	3,000	—	– 3,000
Cable ditto covered with lead and iron-armoured.—			
From Germany	165,000	53,000	– 112,000
,, Great Britain ...	1,000	—	– 1,000
Total	166,000	53,000	– 113,000
Cable insulated with rubber or paper and covered with textiles.—			
From Germany	171,000	6,000	– 165,000
,, Italy	9,000	184,000	+ 175,000
,, Great Britain ...	16,000	27,000	+ 11,000
,, Other countries ...	5,000	1,000	– 4,000
Total	201,000	218,000	+ 17,000
Cable ditto covered with lead.—			
From Germany	12,000	—	– 12,000
,, Austria	187,000	—	– 187,000
,, Other countries ...	1,000	3,000*	+ 2,000
Total	200,000	3,000	– 197,000
* Italy.			
Dynamo-electric machines and electric transformers.—			
From Germany	1,224,000	900,000	– 324,000
,, France	90,000	25,000	– 65,000
,, Italy	34,000	12,000	– 22,000
,, Great Britain ...	8,000	24,000	+ 16,000
,, Other countries ...	19,000	4,000	– 15,000
Total	1,375,000	965,000	– 410,000
Accumulators, batteries, electrodes.—			
From Germany	222,000	103,000	– 119,000
,, Austria	70,000	—	– 70,000
,, France	31,000	10,000	– 21,000
,, Other countries ...	8,000	32,000*	+ 24,000
Total	331,000	145,000	– 186,000
* Italy 29,000 fcs.			
Insulators, mounted.—			
From Germany	78,000	33,000	– 45,000
,, France	2,000	1,000	– 1,000
,, Other countries ...	2,000	—	– 2,000
Total	82,000	34,000	– 48,000
Electric meters.—			
From Germany	697,000	873,000	+ 176,000
,, France	85,000	111,000	+ 26,000
,, Italy	10,000	7,000	– 3,000
,, Great Britain ...	3,000	3,000	—
,, Other countries ...	7,000	4,000	– 3,000
Total	802,000	998,000	+ 196,000
Telegraph and telephone apparatus.—			
From Germany	474,000	191,000	– 283,000
,, Belgium	277,000	35,000	– 242,000
,, Great Britain ...	318,000	45,000	– 273,000
,, Sweden	90,000	58,000	– 32,000
,, Other countries ...	53,000	20,000	– 33,000
Total	1,212,000	349,000	– 863,000

EXPORTS.

The following figures show the exports of electrical and similar machinery from Switzerland in 1914 compared with 1915. The diversity of Switzerland's growing export trade is noteworthy :—

	1914. Francs.	1915. Francs.	Inc. or dec. Francs.
Dynamo-electric machines and electric transformers of all kinds.—			
To Germany	2,257,000	2,998,000	+ 741,000
,, Austria	525,000	893,000	+ 368,000
,, France	3,002,000	3,523,000	+ 521,000
,, Italy	1,158,000	1,089,000	– 69,000
,, Belgium	401,000	35,000	– 366,000
,, Great Britain	2,014,000	1,798,000	– 216,000
,, Russia	2,019,000	843,000	– 1,176,000
,, Spain	738,000	1,204,000	+ 466,000
,, British India	30,000	201,000	+ 171,000
,, Mexico	65,000	—	– 65,000
,, Brazil	308,000	102,000	– 206,000
,, Argentina	950,000	982,000	+ 32,000
,, Other countries ...	2,111,000	1,578,000*	– 533,000
Total	15,578,000	15,246,000	– 332,000
* Netherlands 497,000 fcs., Norway 611,000 fcs.			
Steam engines, cranes, pumps, turbines, &c.—			
To Germany	941,000	1,515,000	+ 574,000
,, France	673,000	755,000	+ 82,000
,, Belgium	575,000	17,000	– 558,000
,, Russia	1,104,000	1,189,000	+ 85,000
,, British India	49,000	131,000	+ 82,000
,, Japan	97,000	21,000	– 76,000
,, Great Britain	577,000	648,000	+ 71,000
,, Other countries ...	1,884,000	1,186,000*	– 638,000
Total	5,900,000	5,462,000	– 438,000
* Sweden 127,000 fcs., Spain 372,000 fcs., Chile 192,000 fcs.			
Accumulators, batteries, electrodes.—			
To Germany	7,000	21,000	+ 14,000
,, France	47,000	539,000	+ 492,000
,, Italy	7,000	140,000	+ 133,000
,, Greece	—	25,000	+ 25,000
,, Egypt	1,000	—	– 1,000
,, Other countries ...	24,000*	80,000	+ 56,000
Total	86,000	818,000	+ 732,000
* Brazil 8,000 fcs.			
Electric meters.—			
To Germany	437,000	803,000	+ 366,000
,, Austria-Hungary ...	197,000	118,000	– 79,000
,, France	371,000	155,000	– 216,000
,, Italy	276,000	373,000	+ 97,000
,, Great Britain	332,000	387,000	+ 55,000
,, Russia	137,000	400,000	+ 263,000
,, Other countries ...	287,000	668,000*	+ 381,000
Total	2,037,000	2,904,000	+ 867,000
* Includes Spain 150,000 fcs., Japan 153,000 fcs.			
Steam, benzine, and electric locomotives.—*			
To France	1,013,000	68,000	– 945,000
,, Algeria and Tunis ...	436,000	—	– 436,000
,, Dutch East Indies ...	247,000	385,000	+ 138,000
,, Other countries ...	273,000	387,000†	+ 114,000
Total	1,969,000	840,000	– 1,129,000
* Electric locos. in 1914, 146,000 fcs.; in 1915, 11,000 fcs. † Includes Philippines 113,000 fcs.			
Electric cable, not insulated.—			
To Germany	6,000	1,000	– 5,000
,, France	5,000	—	– 5,000
,, Other countries ...	4,000	300	– 3,700
Total	15,000	1,300	– 13,700
Electric cable, insulated with rubber or paper.—			
To Germany	28,000	135,000	+ 107,000
,, France	89,000	4,000	– 85,000
,, Italy	7,000	—	– 7,000
,, Other countries ...	153,000*	20,000†	– 133,000
Total	277,000	159,000	– 118,000
* Norway 12,000 fcs., Turkey 11,000 fcs. † Greece 8,000 fcs., Roumania 11,000 fcs.			
Cable, ditto, covered with lead.—			
To Germany	8,000	1,000	– 7,000
,, Great Britain	57,000	158,000	+ 101,000
,, Other countries ...	3,000	—	– 3,000
Total	68,000	159,000	+ 91,000

	Francs. 1914.	Francs. 1915.	Francs. Inc. or dec.
Cable, ditto, covered with lead, and iron armoured.—			
To Germany	44,000	23,000	– 21,000
,, Great Britain	156,000	12,000	– 144,000
,, France	3,000	—	– 3,000
,, Egypt	2,000	7,000	+ 5,000
,, Other countries ...	105,000*	—	– 105,000
Total	310,000	42,000	– 268,000
* Roumania 5,000 fcs.			
Cable, insulated with rubber or paper, and covered with textiles.—			
To Germany	—	69,000	+ 69,000
,, France	9,000	—	– 9,000
,, Italy	56,000	—	– 56,000
,, Great Britain	124,000	8,000	– 116,000
,, Other countries ...	106,000	10,000*	– 96,000
Total	295,000	87,000	– 208,000
* Roumania.			
Cable, ditto, covered with lead.—			
To Germany	3,000	2,000	– 1,000
,, Other countries ...	6,000*	—	– 6,000
Total	9,000	2,000	– 7,000
* Roumania 5,000 fcs.			

Note.—25 francs = £1.

REVIEWS.

Experimental Wireless Stations. By P. E. Edelman. Published by the author, Minneapolis, U.S.A. Price $1.50.

This work is now in its third edition, and has been brought up to date by a certain amount of general revision and by the addition of a 44-page supplement containing brief notes on various developments likely to interest the wireless experimenter, and capable of being tested or applied by him. A very useful list is given of United States patents on wireless telegraphy, telephony, and control, classified under various subject headings, and covering the period 1881 to January 1st, 1916. As regards the main portion of the book, which dates from 1912, and is probably known to many readers, the author has taken up the standpoint that the average "amateur" wireless worker is really an earnest student of the subject, and not far removed from the skill and opportunities of the professional operator or inventor. Keeping this principle before him, the author gives a clear and practical treatment of the theory, design, construction, and operation of experimental wireless stations. The amount of theory included is only such as is likely to be really useful to the reader, and no space is expended on historical or elementary matter, or on half-tone illustrations showing only the general appearance of apparatus. The book is very well illustrated by clear line diagrams. A point to which the author rightly attaches great importance is the necessity for working with sharply tuned wave lengths; unless this is done, experimental wireless stations, by their very number, become an intolerable nuisance to each other and to commercial stations.

Beginning with a general treatment of the nature and theory of wireless transmission, the author passes on to a description of types of aerial, and gives useful suggestions for their construction. Grounds and lightning protection are treated in similar manner, and the next two chapters are devoted to resonance and the general features of transmitters, and to the calculation of wave length, capacity, and other circuit calculations. It is due to lack of clear ideas and reliable basic data that the average experimenter is disappointed so frequently in the performance of his equipment. A good treatment is given of the use and construction of auxiliary equipment, transmitting condensers, inductances, spark gaps, and various measuring instruments. The chapter on continuous waves, wireless telephony, and so on might be extended with advantage. The final half-dozen chapters, on the receiving station and its equipment, are excellent, especially the sections dealing with detectors, and with tuning and the prevention of interference. The table of contents is peculiarly placed between the main body of the book and the supplement; the index comes at the end, but is meagre. The book should be very useful to anyone interested in experimental wireless work.

Engineering Applications of Higher Mathematics, Part V, Problems in Electrical Engineering. By V. Karapetoff. New York, U.S.A.: John Wiley & Sons. Price 3s. net.

This volume is very obviously in the nature of a mathematical addendum to the author's two treatises, "The Magnetic Circuit" and "The Electric Circuit." It deals with a few of the important problems in electrical engineering, and applies the calculus to their solution. The mathematics required is in no case of a very advanced character—a somewhat surprising fact in view of the title of the book. Some explanation of this is, perhaps, to be obtained from the preface, in which the author plainly indicates that there is still some uncertainty in American colleges as to the proper place of mathematics in an engineering course, and the proper method of teaching mathematics to engineers.

After referring to the influence of Prof. Perry on his ideas, the author proceeds: "In teaching analytics and calculus to engineering students, the instructor should limit himself at first to a comparatively small number of curves, functions, and transformations, but each of these must be explained and *made concrete* in a number of engineering problems." He then remarks that most engineers are not natural mathematicians, and consequently the correct method of training them in mathematics is to work from the concrete to the abstract: from the specific practical case to the general case. He concludes that "either our instructors in mathematics must come to understand the difference between their temperament and that of their students, or else mathematics in engineering colleges will have to be taught by engineers." Fortunately, we in England have long since recognised the importance of these facts, as witness the excellent text-books in practical mathematics now in use in our technical schools and colleges.

Prof. Karapetoff further suggests—apparently as a quite revolutionary change in American methods—that the teaching of mathematics should be carried through all the four or five undergraduate years, and outlines a "rational course in mathematics for engineering students" covering five years. It is interesting to note that this course follows exactly on the lines of the courses given in the best technical schools and colleges in this country, and it is very remarkable that a professor at Cornell University should regard such a course as anything beyond the ordinary and necessary nucleus of an engineer's college training.

All this casts an interesting sidelight on American methods of technical instruction, and incidentally explains the reason for the introduction of chapters on seemingly elementary, and almost irrelevant, mathematics into quite advanced American scientific and technical manuals, of which Karapetoff's treatise on "The Electric Circuit," reviewed in our issue of September 13th, 1912, is a striking example.

The six important problems studied in this book are as follows: Resistance of non-cylindrical conductors and magnetic paths; minimum weight of metal in a combination of conductors; most economical size of conductors; a leaky direct-current line; average and effective values of voltage and current; efficiency and losses in electrical machinery. Twenty or thirty examples are worked out in each section, and all the practical cases are included. Very neat proofs are given in many cases, notably in connection with efficiency and resistance calculations, and the practical and economical considerations which modify the answers obtained by mathematics are indicated in such cases as determining the cross-section of conductors. The section on average and effective values of voltages and currents is extremely well written and useful; there is also a useful appendix on maxima and minima.

A bibliography is given at the end of the book, and English electrical literature is represented by the works of Fleming, Lamb, Thomson, and Campbell. Altogether the book is a useful and satisfactory mathematical appendix to the author's larger treatises; it should give breadth and solidity to the knowledge of any engineering students who may use it.—P. H. S. K.

Alternating Current Work. By W. Perren Maycock. London: Whittaker & Co. Price 6s. net.

This book is a revised and extended edition of the author's former work, "The Alternating Current Circuit and Motor," but, as it now includes alternators and transformers, it has been given a new and more comprehensive title. A sub-title describes it as an introductory book for engineers and students, and its scope and objects are set out with considerable frankness by Mr. Maycock in the introductory paragraphs to Chapter I. Here he claims that "it is certain that the subject could not have been treated satisfactorily in a more elementary way," and, after stating that the calculus has not been allowed to show its "fearsome face," and that the very little trigonometry used has been fully explained, he proceeds to enter some interesting remarks concerning mathematics and the electrical engineering profession.

"Good mathematical knowledge is an accomplishment worthy of great respect, and is of decided advantage to an engineer, provided he does not neglect other aspects of his work. But those who—through lack of tuition or sheer mental inability—are unable to rise to such heights, may comfort themselves with the reflection that there is plenty of room for distinction in other ways. It is easy to imagine numerous cases . . . where the highly mathematical man would only be able to look on while the practical man was righting things. Then there is the indispensable 'commercial engineer,' who often does not possess very special knowledge of either theory or practice, but whose duties would be quite beyond some theorists and practicians."

Now, while we cordially agree with Mr. Maycock that there is room in the profession for both theorists and prac-

ticians, and that very few men can be expert in both capacities, yet we are disposed to doubt the "indispensability" of any electrical engineer to-day who does not possess any special knowledge of either theory or practice. The existence of such gentlemen is beyond dispute, but their desirability is open to question.

After encouraging the reader who may become overawed by the formulæ and vector diagrams by inciting him to "a little application," Chapter I proceeds to specify the nature and complication of the subject of electrical engineering, and to give reasons for the necessity for specialisation in one or more branches of the subject.

Chapter II occupies over 100 pages, and is in itself quite a little text-book of the theory of alternating currents. Following the recent suggestions of Dr. Drysdale, a number of remarkably sound mechanical and hydraulic analogies have been given, and the student's grasp of the effects of resistance, capacity, and inductance in a circuit ought to be materially strengthened by this method of treatment. The models used to obtain these analogies are well illustrated, and the corresponding effects in the A.C. circuit have been represented as far as possible by oscillograms. The method of representing A.C. conditions by means of vector diagrams has been dealt with in an equally unique manner, and the claim of the author to have devised the simplest and least objectionable method of treatment for the less mathematically minded is, in our opinion, well sustained. The vector diagram itself is first introduced with great subtlety, and its application is then insisted upon in a few well-chosen and fully worked out problems. Most of the examples at the end of this and subsequent chapters have been taken from the City Guilds and A.M.I.E.E. examination papers, and answers are given to all the numerical questions.

The next chapter deals with polyphase currents and power measurement, and here, again, the hydraulic analogy is employed with advantage, especially in the descriptions of the wattless current and the Y connection. A few fully worked out examples in the calculation of power in A.C. circuits also add to the usefulness of the chapter. Chapters IV, V, and VI deal in succession with alternators, transformers, and motors. In all cases the various types are classified, their windings are described, and numerous well-figured diagrams given of machines at various stages in course of construction. The synchronism and "regulation" of alternators are given considerable attention, and numerous calculations of transformer losses and efficiency are given.

The production of the rotating field by 2 and 3-phase currents is well described and illustrated, and its practical application to the running of motors is treated with equal thoroughness. Important sections of the chapter on motors are also devoted to single-phase induction and repulsion motors, and to motor calculations. This latter section, which has been largely extracted from the author's "Electric Circuit Theory and Calculations," is an exceptionally useful collection of typical motor problems worked out in full, the circle diagram being employed in many cases.

The book concludes with a short account of the uses of motors and the most recent applications of A.C. motors to railway, ship, and crane work. There can be no doubt that this book is, as it is claimed to be, an improvement on the author's former work, "The Alternating Current Circuit and Motor," for in these 400 pages Mr. Maycock has given a very thorough account of his subject. He has had two invaluable allies, to whom due credit is given in the preface—Mr. Hughes, who has collaborated throughout, and to whom are due the solutions to the numerical examples, and Mr. Bishop, who has succeeded admirably in the making of good diagrams. It is also noticeable that the photographs of machinery, &c., are unusually clear and helpful, and are *not* of the usual catalogue description, and that to this end a large number of the important engineering firms have been drawn upon for blocks.

Altogether the book is very sound and satisfactory, and the price is fair and reasonable.—P. H. S. K.

BUSINESS NOTES.

The Census of Production.—By a special Act of Parliament, it is to be arranged that a census of production shall not be taken in 1918, as the present year is a most unsuitable period to cover, and would afford no trustworthy index to the course of internal trade. It is proposed that the Board of Trade shall have power to settle when the next census shall be taken, and shall issue an order a year before the commencement of the year in which the census is to be taken.

Bankruptcy Proceedings.—Oxley, H. H. (otherwise Oliver Huxley), Hanwell, lately of Ealing.—Second and final dividend 6¾d. in the £, payable March 7th, at 14, Bedford Row, W.C.

Cunnington, J. G. S., and Allison, H. P. (Laing, Wharton and Cunnington), 7, Great Newport Street, London, electrical engineers and contractors.—March 21st is the last day for receipt of proofs for dividend by Mr. E. L. Hough, the Official Receiver, at Bankruptcy Buildings, Carey Street, W.C.

Catalogues and Lists.—British Thomson-Houston Co., Ltd., 77, Upper Thames Street, London, E.C.—Complete lamp catalogue, comprising eight sections, dealing with drawn tungsten filament lamps in various types, including standard (vacuum) lamps, half-watt type lamps, focusing or projector-pattern lamps of both vacuum and half-watt types, automobile and battery lamps, including half-watt models for motor-car headlights, lamps for medical, surgical, and scientific applications, B.T.H. carbon filament lamps for lighting and for radiator use, and carbon lamps for decorative purposes, the first section being devoted to useful tables and data relating to incandescent lamps in general and to B.T.H. lamps in particular. These sections are bound together in a stout tinted cover of attractive design. Every type of lamp (no fewer than 67 are illustrated) is priced, with its dimensions, wattage, form of cap, and output of light. The lighting values are expressed in terms of the lumen, which gives the total flow of light emitted irrespective of direction, shape of filament, or equipment of the lamp.

The company has also issued Incandescent Electric Lamp Handbook No. 3, of 64 pages, specially dealing with Mazda electric lamp bulbs for all makes of motor-car in use. Copies will be sent to electrical contractors, motor dealers, &c., on application.

Enterprise Manufacturing Co., Gun Street Electrical Works, Bishopsgate, London.—Illustrated circular relating to their new type of fuseboard.

Trade Announcements.—The L.P.S. Electrical Co. have moved their offices and stores to 14, Howick Place, Westminster, S.W. Telephone number: "Victoria 7346." Telegraphic address: "Engineyor, Sowest, London."

We understand that Messrs. Quead, Ltd., have appointed the Australian General Electric Co., of Melbourne, their agents for Australia, and the South African General Electric Co., for South Africa, for all their electric fires.

With reference to the notice under "Change of Address," last week, we are asked to state that only part of Queen Anne's Chambers, Westminster, has been taken over by the Government. Mr. George Ellison, whose London offices were in the building, announces that he has removed to 25, Victoria Street, Westminster, and that his telephonic and telegraphic addresses are unaltered. Messrs. Mossay & Co., Ltd., of Queen Anne's Chambers, S.W., have also changed their premises for the same reason to 7, Princes Street, Westminster, S.W.

The telephone numbers of the Unbreakable Pulley and Mill Gearing Co., Ltd., Cannon Street, E.C., have been altered to "6131 City" (two lines).

Vickers's Enterprise in Italy.—A further important development of British enterprise in Italy has recently been arranged. We learn that Sir Vincent Caillard and Mr. F. Barker, directors of Messrs. Vickers, have been elected directors of the Società per le Imprese Idrauliche ed Elettriche del Tirso and of the Società per le Forze Idrauliche della Sila, in which companies the Banca Commerciale Italiana and its industrial group are largely interested. The object of the two companies, to whom special concessions have been made by the Italian Government, is the development of hydro-electric power for industrial purposes, and also for agricultural irrigation in Sardinia and the southern provinces of Italy. Hydro-electric power stations will be erected to develop the power of the Rivers Tirso in Sardinia and Sila in Calabria. The two companies have already got to work on an ambitious programme, which, with the participation of British capital and enterprise, is expected to apply a great stimulus to industrial expansion in Southern Italy and Sardinia after the war. Incidentally, the arrangement may be regarded as the driving of another nail in the coffin of German commercial penetration in Italy.—*The Times.*

Book Notices.—"*Proceedings* of the American Institute of Electrical Engineers." Vol. XXXVI, No. 2. February, 1917. New York: The Institute.

"Annual Report of the Smithsonian Institution for 1915." Washington: Government Printing Office.

"Technologic Papers of the Bureau of Standards." No. 74. Investigation of Cartridge-Enclosed Fuses. Washington: Government Printing Office.

"Firm-Names Register." By G. W. Daines. London: Information Bureau. 3d.—This is a pamphlet reprint from the *Financial News*, dealing with the "Registration of Business Names Act" for the "man in the street."

Owing to the war, *Cheap Steam*, the interesting monthly issued by Messrs. E. Bennis & Co., Ltd., will be issued bi-monthly until times become more normal.

Liquidations.—Jaeger Bros., 9, Rathbone Place, Oxford Street, London, W.—The controller, Mr. Maurice Jenks, of 6, Old Jewry, E.C., has applied for his release.

Ship Carbons, Ltd., 5, Chancery Lane, London, E.C.—The controller, Mr. W. Hancock, 90-91, Queen Street, E.C., has applied for his release.

Prices Advance.—The Sterling Telephone and Electric Co., Ltd., have issued a circular to the trade announcing increases in prices of switchboards and magneto telephones.

LIGHTING AND POWER NOTES.

Aberdeen.—The Electricity Committee reported the renewal of the agreement, for 12 months, for the supply of electricity to the Great North of Scotland Railway Co.

Argentina.—The Compania Alemana Transatlantica de Electricidad has petitioned the Chamber of Deputies asking that coal and petroleum may be exempted from the operation of the new law, which imposes a 5 per cent. import duty on goods hitherto imported free of duty.—*Review of the River Plate.*

Australia.—The Sydney City Council's Electric Light Committee has considered the recommendation of the city electrical engineer to accept no new contracts for lighting excepting for places where artificial lighting is not already installed. Mr. Mackay, the city electrical engineer, said that it was impossible to obtain the necessary machinery, as British firms had received instructions to execute no work that was not required for the war. He had approached the Chief Commissioner for Railways (Mr. Fraser) to see if an arrangement could be made for the City Council to draw on the railway power house for a period of three years; he understood the Commissioners worked on a margin of 6,000 KW. at White Bay. Mr. Fraser said he would advise him in six months' time if an arrangement could be made, and he (Mr. Mackay) thought that some relief might be forthcoming from that direction when the six months elapsed. The recommendation was agreed to, with the addition that the city treasurer be instructed to ascertain what amount of money it was possible to borrow, and the rate of interest, for the purchase of additional plant, &c.

Birmingham.—Report on Electric Supply.—The report of Councillors Appleby and Beale on the causes of the recent interruptions of electricity supply in the city has now been published. It finds that such failures were due primarily to the abnormal demand for electric current, which came at a time when the Committee was least able to meet it, and that this situation arose from causes which were not beyond the control of the Committee. The chief engineer, Mr. Chattock, in 1910, reported that new plant would be required before a new station could be finished and proposed extensions at the Summer Lane station, which would defer for two years the necessity of a new station. In October, 1911, the purchase of the Nechells site and raising of £500,000 was agreed to, it being supposed that the station would be ready for 1915-16. The reporters consider that it is the failure to carry out this programme which is at the root of the trouble, and blame both the engineer and Committee for the delays which took place, pointing out that from December, 1912, onwards the former did not have the support of the whole of the Committee, although in the end the engineer's original recommendations were adopted. The report concludes with an expression of anxiety for the future. Although the temporary station will receive 6,000 KW. of additional plant this summer, it is doubted whether this will meet the case.

The members of the Electric Supply Committee who were members in 1911—viz., Ald. Jephcott, Ellaway, and Bird, also Councillors Burman, Hawker, Heath, and Marks, have replied to the above report, pointing out that prior to the war the plant appeared to be sufficient for the needs of the undertaking, and emphasising their opinion that the failures have been due to the abnormal demand for energy during the war. In reference to the delays, they state that if the Committee erred on the side of caution it should be remembered that economy and prudence in expenditure were regarded as superlatively important at that time. The reply further states, in reference to the future, that since the report was prepared negotiations have been practically completed whereby a further 10,000 KW. of plant will be available for the city's use, by arrangement with a local firm.

At the end of the present year the generating plant erected since August, 1914, ought to be 32,000 KW., which is 7,000 KW. more than the permanent station would have held had it been completed. The demand for energy is being overtaken, but the spare plant is admittedly meagre, and the Committee is very strongly of opinion that even now the permanent station should be proceeded with. Plans are now in preparation, and, in order to allay any anxiety which might be aroused by observations in the report, the Committee has asked Mr. C. P. Sparks (president, Institution of Electrical Engineers) to furnish a report on the extension scheme.

The chief engineer, Mr. Chattock, at the request of the Committee, presented a statement with reference to the report as it affected him personally, disagreeing with the suggestion made that the difficulties of foundations were not appreciated by himself and the Committee.

He points out that some months were taken up in 1913 in considering alternative schemes for ferro-concrete rafts and piles, and that no material delay arose from an alteration in size of the switch house. He concluded by pointing out the impossibility of obtaining the normal amount of steam with fuel of the character now used.

Both the reports were approved by the Council.

Canada.—The Imperial Trade Correspondent at Toronto reports that the Ontario Hydro-electric Commission will again be a large buyer of motors, copper wire, insulators, generators, and power plant during 1917. The Commission has now decided to carry out its own power plant construction, which will probably be commenced during the coming spring. The Commission will also require large quantities of electric railway plant in connection with the scheme of electric radial railways throughout the province.—*Board of Trade Journal.*

Chippenham.—Workhouse Lighting.—The B. of G. has decided to enter into a contract with the Electricity Co. on agreed terms for the lighting of the workhouse.

Continental.—Portugal.—Owing to the shortage of coal caused by the German interference with neutral shipping, the gas and electricity works at Cadiz will close on March 12th if no solution of the difficulty can be found.—*Times.*

Dundalk.—The Council has taken steps to get a legal decision as to whether the L.G.B. has power to sanction a loan for working capital for the electricity undertaking. The Board has already held, on legal advice, that it has no such power, but it is felt that the matter is one that should be contested in a friendly way. The Courts are to be told, it is understood, that it would be of no service for the Council to borrow £50,000 for plant and buildings, if it had not money to work the plant until revenue had been brought in.

The Council has adopted a report by the Electricity Committee recommending, owing to increases in cost of fuel-oil, that, as from April 1st, the following further increases be made in the supply tariffs:—10 per cent. on existing power and heating tariffs, making a total increase of 20 per cent. on pre-war rates; the present contract rate for town lighting to be increased in the same proportion as the increase, dating from July 1st last, on private lighting:—viz., by one-sixth. It is probable that the work of adapting the two new engines to burn tar oil will not be completed for six months.

Enniscorthy (Co. Wexford).—Loan Sanction.—The L.G.B. has sanctioned an application of the Urban Council to borrow a loan of £6,000 in connection with the local electric lighting scheme.

Halifax.—Proposed Loan.—The Tramways and Electricity Committee has instructed the town clerk to make application to the L.G.B. for consent to the borrowing of £10,000 for the installation of a new boiler, economiser, &c., required at the electricity works.

Heston and Isleworth.—Price Increase.—The electrical engineer reported to the Council that the effect of Summer Time lighting last year, compared with the returns for the previous year, 1915, was a falling off in units sold from 38,315 to 27,640, and in revenue from £606 to £436. In public street lighting the units sold dropped from 27,168 to 1,025, with a drop in income from £500 to £351, a gross loss of income of £318. There were, moreover, 51 more consumers than in the previous year. He estimated the loss on the coming summer at £400, and he advised that there should be an increase in charges from April 1st by 12½ per cent. to all classes of consumers, making a total advance of 25 per cent. on pre-war prices, and also that a minimum charge of 6s. 8d. per quarter be enforced. The Electric Lighting Committee recommended that this increase be made, and this was agreed to.

Horsham.—Price Increase.—The U.D.C. has decided that, as from March 31st, the maximum demand rate for electricity supplied for power, heating and private lighting be discontinued, and that a flat rate of 6d. per unit be charged for private lighting (except for places of worship and the fire station, which would be supplied at the present rates, 5d. and 4d. per unit respectively), and for power and heating a uniform charge of 2d. per unit. It was estimated that the extra revenue to be obtained from these alterations would be £650 per annum.

Kendal.—For the year ending March 31st, 1917, it is estimated that there will be a net deficit of £978 on the working of the electricity department. For the month ended January 31st last, the units generated were 16,805, as against 18,863 in January, 1916.

Kilmallock (Co. Limerick).—Plans have been prepared for constructional work for the more efficient working of the scheme of the Kilmallock Electric Light and Power Co., Ltd.

Kingston-on-Thames.—Year's Working.—For the ensuing financial year there will be a deficit on the electricity undertaking of £1,700, which means the addition of 2d. in the £ to the rates. Councillor Kerrison, chairman of the Lighting Committee, explaining the deficit, said that in April last the two-cycle Diesel engine crankshaft was fractured, and they had not yet got the use of the engine again, while the cost of the new crankshaft would be £1,050. Then, on December 8th, the four-cycle Diesel engine broke down, and to the end of the financial year they were not allowed by the insurance company to work it more than 42 hours a week. Then they had to face a very heavy increase in the cost of coal. Councillor Waters objected to adding the £1,700 to the rates, and said the undertaking had been a failure and a muddle from the start. Councillor Kerrison, replying to the discussion by permission of the Council, said the Diesel engines were now insured, and they had received £200 for consequential damages, plus the cost of repairs to the four-cycle engine. He estimated that the increased charge for current would bring them in over £2,000. The daylight saving made a difference of 22 per cent. at night, when they got the best price for the current. A recommendation to add 2d. to the general district rate was agreed to. Later in the meeting, Councillor Kerrison moved, and it was agreed, that an addition of 20 per cent. be made to accounts for electricity after March 31st next. In reply to a criticism by Councillor Waters, he stated that they were going to see the few firms who had agreements running, and ask for a concession in view of the exceptional cost of production at the present time.

Leeds.—Loan Sanction.—The L.G.B. has sanctioned the borrowing by the Corporation of £17,128 for two boilers and other plant at the electricity works.

Liverpool.—At a recent meeting of the Mersey Docks and Harbour Board it was mentioned that experiments were being made with electrical stacking machines, such as were employed at the Manchester Docks.

London.—Woolwich.—The Highways Committee of the L.C.C. is proposing arrangements for additional power supply in the Woolwich district, at an estimated cost not exceeding £30,000.

Marylebone.—The Electric Supply Committee has authorised the special war purposes tariff of 1d. per unit (plus war advance of 20 per cent.) for current consumed at a garage in connection with the Red Cross House. The Committee has decided to discontinue the special rate for premises used for war purposes in cases where the Government is making a grant towards the expenses of the institution.

Deptford.—The Council is urging that, considering the brief period of darkness during the months of May, June, July, and August resulting from the adoption of the Daylight Saving scheme, it is desirable to dispense with street lighting during those months, thereby effecting a considerable saving of fuel and labour.

Rochdale.—A somewhat more reassuring statement as to the position at the Corporation electricity works was given by the chairman of the Committee at the monthly meeting of the T.C. last week. Councillor Walker said that at present matters were satisfactory, but the load they were grappling with was an exceptionally heavy one, and it was quite possible that interruptions might take place in the future, though things would be better than recently. In the year ending March, 1914, the output was 6,000,000 units, in 1915 it was 7,000,000, in 1916 12,000,000, and in the year ending this month the figure would be 16,500,000, and if they could have met all demands for electricity it would have exceeded 21,000,000 units.

Todmorden.—Plant Extension.—The Corporation proposes to spend £10,000 on new plant for the electricity works.

U.S.A.—Niagara Power.—According to the *Electrical World*, an additional block of 50,000 H.P. has been requisitioned by the Ontario Hydro-Electric Power Commission, not later than April 1st, which will lead to further curtailing of the power sent into New York State. The announcement of the new demand came as a complete surprise to the power companies and industries along the Canadian Niagara frontier. Although the additional 4,400 cb. ft. of water per sec. now allotted to American generating companies will relieve the situation, the cutting off of a further 50,000 H.P. will leave matters as before the extra water was granted. The temporary permit for the latter expires on July 1st, and unless extended, will shut down or lead to the removal to Canada, of many industries.

Wigan.—Price Increase.—The Electricity Committee has decided to increase the price of electricity for lighting purposes, as from April 1st next, by 7½ per cent. over and above the present prices, making the charges as follows:—Churches and offices, 5½d. per unit; shops and dwelling houses, 4½d. per unit; public houses, restaurants, and theatres, 3½d. per unit.

York.—Price Increase.—The Electricity Committee has decided that the charges for electrical energy supplied to private consumers and users of power be increased by 10 per cent. as from April 1st.

TRAMWAY and RAILWAY NOTES.

Accrington.—The Tramways Committee, in reply to a request by the Amalgamated Association of Tramway Workers for payment of the 6s. 6d. war bonus to female conductors, &c., which was awarded to the men by the Committee on Production, has intimated that it cannot depart from the terms of the award.

Australia.—It has been decided by the Government to put in hand at once a section of the contract for the construction of the Sydney City Railway from Central Station to St. James Road, the reason being that the metropolitan tramway traffic has become so congested that relief is imperatively necessary; part of the scheme is to electrify the railway system, both suburban and country, for a certain distance out of Sydney.

A start is to be made immediately with the electrification, by converting the Hurstville and Bankstown lines; this will enable the trains from these suburbs to go right down to Circular Quay when the first section of the City Railway has been built.

The report on the working of the undertaking of the Adelaide Municipal Tramways Trust for the two years ended July 31st, 1916, shows that the Port Adelaide tramway system is now being electrified, while about 55 miles of route are already in operation by the Adelaide authorities, with 170 cars. We note that the Woods-Gilbert rail planer has been used with satisfactory results for removing corrugations, and some 97,000 ft. of running rail have been dealt with during 1915 and 1916. The total revenue from electrical working for the year ended July, 1916, was £322,759, as compared with £309,914 in the previous year; the total operating expenses were £193,964, as against £191,069; interest, sinking fund and reserve appropriations absorbed practically the whole of the balance, the total amount paid into sinking fund to date being £203,683, and into reserve £107,581, plus some £9,000 Third Party Accident reserve. The passengers carried exceeded 43 millions, 4,700,000 car-miles being worked. Roughly, 2 units per car-mile were required for traction and car lighting.

Belfast.—At the monthly meeting of the Corporation, attention was drawn to the unsatisfactory state of the tramway track and to the number of half-empty cars which ran constantly to Glengormley. In reply, it was stated that the city surveyor was fairly well satisfied as to the state of the track generally; and the Committee would consider the Glengormley service.

Blackpool.—The line between South Shore Station and the borough boundary at Squire's Gate, which is leased by the Corporation to the Blackpool, St. Annes, and Lytham Tramways Co., will be taken over by the Corporation on July 26th next, when the lease expires. The company will have running powers only after that date, though its cars will be still allowed to run to Central Station and Manchester Square.

Mr. C. Furness, the tramway manager, has been authorised to commence the training of a number of women as drivers, so as to ensure a satisfactory service when more cars are required during the summer season.

Castleford.—Fire.—A serious fire, which broke out at the depôt of the Yorkshire (W.R.) Tramways Co., on Monday morning last, resulted in the destruction of eight cars, besides more than half of the roof of the shed. The whole of the repair shed was also burnt out. The damage is estimated at anything between £10,000 to £15,000. Eight cars (which were got out practically undamaged) are being used under the abnormal conditions to keep open the service of cars for the section from Normanton through Castleford to Pontefract. The power station adjoining the shed, fortunately, escaped injury.

Croydon.—Electric Tower Wagon.—The Tramways Committee recommended that an Edison electric tower wagon be purchased, at a cost, including charging gear, of £921, the amount to be defrayed out of the reserve and renewals fund. The annual cost of running the wagon is estimated at £21; the recommendation was agreed to by the Council.

Dublin.—The Chief Secretary for Ireland has intimated that he cannot recommend the Government to take control of the Dublin and Lucan Electric Railway owing to its being a line of a tramway character. The railway carries an average yearly of 421,000 passengers, and serves Chapelizod, Palmerston, and other districts along the Liffey Valley to within a mile or so of the famous Salmon Leap at Luxlip, Co. Kildare, and connects with the Dublin United Tramways service from O'Connell Bridge and Sackville Street.

East Ham.—Halfpenny Fares.—Although 51·392 per cent. of the total passengers carried on the Council's system are halfpenny fares, the income derived therefrom is only 32·35 per cent. of the total. Under the circumstances, the Tramways Committee has decided to abolish the issue of halfpenny tickets to adults.

Haslingden.—The T.C. is to receive a report on the proposed increase by Accrington of the through fare to Haslingden; also, on a further proposal by that Corporation to increase the charge for electricity supplied in bulk to Haslingden.

Northampton.—Revised Fares.—The Tramways Committee has decided that all fares other than the ordinary penny ticket, the ½d. early morning ticket, and children's tickets be abolished. The increased revenue from this and a revision of the parcels rate is estimated at £2,000 per annum.

TELEGRAPH and TELEPHONE NOTES.

France.—The Colonial Minister is having a wireless station installed at Guadeloupe.—*Journal Télégraphique.*

Holland.—A company has been formed at Amsterdam, by the great shipping companies, with the style Nederlandsche Telegraaf Maatschappij "Radio-Holland," for the installation and operation of wireless stations on board Dutch merchantmen.—*Journal Télégraphique.*

Reception of Cable Telegrams by Sound.—The U.S. Minister for War has announced that, as the result of numerous experiments, a method of receiving cable telegrams by sound has been developed, and appears capable of replacing the processes at present in use. The improvement consists essentially in the use of a "ticker" and lamps of the "audion" type, like those used for the reception of wireless signals, in conjunction with an ordinary telephone receiver. The feeble incoming current, which is normally inaudible, is made intermittent by the ticker, and then amplified with the audion. It is stated that the sensitiveness of the apparatus is so great that less than $\frac{1}{10}$ of the voltage required to actuate the siphon recorder suffices to give comfortable reception.—*Journal Télégraphique.*

Telegram Rates.—The rates to Brazil have been fixed at 4s. 7d.—5s. 1d., and to Morocco at 5d. a word.

CONTRACTS OPEN and CLOSED.

OPEN.

Australia.—Adelaide.—March 28th. P.M.G.'s Department. Telephones, telephone parts, line and battery material, &c. Schedules 444 to 453. See "Official Notices" February 2nd.

Belfast.—March 14th. Electricity and Tramways Committee. Six or twelve months' supply of stores, including several electrical items, for the Electricity Department. See "Official Notices" Feb. 23rd.

Burnley.—March 19th. Electrical goods, for the Board of Guardians. Mr. J. S. Horn, Clerk.

Canada.—March 28th. Toronto Electric Commissioners. Synchronous condensers, 5,000, 7,500 or 10,000 K.V.A. capacity. See "Official Notices" February 9th.

Glasgow.—April 5th. Corporation. Turbo-alternators (15,000 KW.), transformers, and condensing plant for the new generating station at Dalmarnock. Particulars from Mr. W. W. Lackie, Chief Engineer and Manager, 75, Waterloo Street, Glasgow.

London.—St. Pancras.—April 12th. B.C. Arc lamp carbons. See "Official Notices" to-day.

Londonderry.—March 17th. Corporation. Engine-room stores, carbons, electricity meters, cables, &c., for the Electricity Department. Town Clerk.

Macclesfield.—March 14th. Cheshire County Asylum. Electrical goods for one year. Mr. W. G. F. Tingay, Clerk to the Asylum, Parkside.

March 14th. Corporation. Nine 40-H.P., three-phase, slip-ring motors. See "Official Notices" February 23rd.

Merthyr Tydfil.—March 13th. Electrical accessories for six months, for the B. of G. Mr. F. T. James, Clerk, 134, High Street.

Redditch.—March 15th. 500 tons of D.S. nuts per month for six or twelve months. Mr. R. N. Mayne, Engineer and Manager, Electricity Works.

Rhondda.—March 21st. U.D.C. Twelve months' supply of house-service meters. See "Official Notices" March 2nd.

Salford.—Uniforms for Tramway Department. General Manager, Tramway Offices, 32, Blackfriars Street.

Stockton-on-Tees.—March 12th. Stores for the T.C. Electricity Department. See "Official Notices" February 23rd.

CLOSED.

Australia.—P.M.G.'s Department, Queensland :—

7,250 dry cells, £1,284.—Deamond Engineering & Trading Pty., Ltd.

Commonwealth Department of Works and Railways :—

14 D.C. motors, control equipment, and spares, for Port Augusta, £1,663.—Electric Construction Co., Ltd.

7 electric capstans and spares, for power house, Darwin, £3,060.—Gibson, Battle & Co., Ltd.

Victorian Public Works Department :—

Mechanical stoker at Kew Hospital, £139.—J. O'Grady. —*Tenders.*

Derby.—The T.C. Electricity Committee has accepted the following tenders :—

E. Morley & Sons.—Power station extensions, £12,150.

J. A. Aiton, Ltd.—Steam piping, £424.

Hill Bros.—Purchase of 1,000-H.P. Ferranti plant at the power station, £1,050.

Derby Coal Co., Ltd.; Mr. T. Walker; G. J. Parr & Sons; and Brookhouse, Johnson, Ltd.—Coal.

London.—Marylebone.—B.C. Accepted tender :—

Pritchett & Gold.—Maintenance of the storage batteries at Aybrook Street and Rathbone Place sub-stations, £88.

Manchester.—The Tramways Committee has accepted a large number of tenders for accessories, parts, trolley poles, lamps and other lighting material, insulating material, carbon brushes, cables and wires, oils, and other requirements for the undertaking.

Nuneaton.—Corporation Electricity Committee :—

G. & J. Weir & Co.—Steam-driven feed pump, £110.

Griff Colliery Co.—1,000 tons of nutty slack, 12s. 2d. per ton at the pit.

Salford.—Tramways Committee. Accepted tenders for stores include the following :—

Car accessories (electrical).—British Westinghouse Co., £843; Manchester Armature Repairing Co., £838; L. Andrew & Co., £244; Western Electric Co., £125; Ward & Goldstone, £98; B.I. & Helsby Cables, £72; and other firms for smaller amounts.

Car accessories (mechanical).—Tandem Smelting Co., £342; British Westinghouse Co., £2,520; Hadfields, Ltd., £1,344; National Rail and Tramway Appliances Co., Ltd., £965; Brown, Bayley's Steel Works, £1,283; G. W. Allsop, £920; Anti-Attrition Metal Co., £134; and other firms for smaller amounts.

Special car accessories.—British Westinghouse Co., £188.

Ears, frogs, &c.—B.I. & Helsby Cables, £115; Britannia Lamp & Accessories Co., Ltd., £67.

FORTHCOMING EVENTS.

Physical Society of London.—Friday, March 9th. At 5 p.m. At the Imperial College of Science, South Kensington, S.W. Ordinary meeting.

Junior Institution of Engineers.—Friday, March 9th. At 8 p.m. At 39, Victoria Street, S.W. Lecture on "X-ray History," electrically illustrated, by Mr. C. Major.

Friday, March 16th. At 8 p.m. Paper on "Munition Work Abroad," by Mr. C. P. Barber.

Salford Technical and Engineering Association.—Saturday, March 10th. At 7 p.m. At the Royal Technical Institute, Peel Park. Paper on "Our Aerial Ocean," by Mr. J. Bacon.

Chief Technical Assistants' Association.—Saturday, March 10th. At 3 p.m. At the Tavistock Hotel, Covent Garden, W.C. Paper on "The Treatment of Water and the Removal of Scale," by Mr. J. H. Parker. Annual general meeting.

Institution of Civil Engineers.—Monday, March 12th. At 5.30 p.m. At Great George Street, Westminster, S.W. Lecture on "Foreign Trade and its relation to the Investment of Capital Abroad," by Mr. E. Crammond.

Institution of Electrical Engineers (Manchester Local Section).—Tuesday, March 13th. At 7 p.m. At the Engineers' Club, 17, Albert Square. Paper on "Voltage Regulation of Rotary Converters," by Mr. G. A. Juhlin.

(Newcastle Local Section).—Monday, March 12th. At 6.45 p.m. At the Mining Institute. Paper on "The Principles involved in Computing the Depreciation of Plant," by Mr. F. Gill and Mr. W. W. Cook.

Belfast Association of Engineers.—Thursday, March 15th. At 7.45 p.m. At the Municipal Technical Institute, College Square. Paper on "An Anticipating Governor for Marine Engines," by Mr. A. Kerr.

Institution of Mechanical Engineers.—Friday, March 16th. At 6 p.m. At the Institution of Civil Engineers, Great George Street, S.W. Papers on "Heat Treatment of Large Forgings," by Sir Wm. Beardmore, Bart.; and "Heat Treatment of Steel Forgings," by Mr. H. Hashdown.

Electro-Harmonic Society.—Friday, March 16th. At 8 p.m. At the Holborn Restaurant, W.C. Smoking concert.

Association of Mining Electrical Engineers.—Saturday, March 17th. At 4.30 p.m. At the Royal Technical College, Glasgow. Paper on "Maintenance of Underground Plant," by Mr. M. Baird, jun.

NOTES.

Linking-up Electricity Works.—An important Conference of electric lighting authorities in Lancashire and Cheshire was held in the Manchester Town Hall, on Friday last, when the Lord Mayor, Ald. Smethurst, presided over a representative attendance. Mr. G. H. Roberts, M.P., Parliamentary Secretary to the Board of Trade, and other officials of the Board were present. Forty-two undertakings were represented.

Mr. Roberts said that a cheap and ample supply of electricity was absolutely essential to national development, and in May last a circular letter was sent to the various electric lighting undertakings throughout the country, pointing out the need for the strictest economy in view of the shortage of coal. The Board of Trade held a high opinion of the report, containing a scheme for the linking together of supply works, which had been issued by the Lancashire and Cheshire authorities, and they considered that it contained valuable suggestions. Electricity was playing a very great part in the development of our industries, and the Board of Trade realised the new importance of the problems to be considered. They believed that the policy pursued in the past had not been the right one, and the Board were prepared to give sympathetic consideration to the matter for which the Conference had been called. The nation had been caught unprepared for war, added Mr. Roberts, and it was for us to see that we were not caught unprepared for the problems which would confront us when the war was over.

Mr. S. L. Pearce, engineer to the Manchester Corporation electricity undertaking and chairman of the Interconnection Committee, said the scheme, as at present outlined, was in skeleton form, but he did not consider that the clothing of it would raise any insuperable difficulties. If the proposals for interconnection were carried through, there would be an annual saving of £82,000 in coal.

The Manchester Electricity Committee had considered the scheme, and had given it their unqualified approval, said Mr. Dagnall, the chairman; and Mr. L. C. Evans, town clerk of Salford, said they were prepared to join hands with other authorities in the matter. Several other local authorities also announced their support, and Councillor Russell Taylor, chairman of the Liverpool Corporation Committee, said the war had demonstrated the enormous amount of waste that had taken place.

Mr. Roberts said the next step would rest with the Interconnection Committee. They would have to work out details of the scheme, and then submit them to the Board of Trade. They all wanted the most economical form of production, he said, and unless they could secure that within the next few years, Great Britain would be deposed from her great position of commercial eminence. Electricity provided one of the greatest possibilities for the development of national industries, and the Board of Trade recognised its importance.

Whilst going to press we have received the official report of the proceedings, of which further particulars will appear in our next issue.

At a meeting of Torquay Town Council on Tuesday, the electrical engineer and manager reported attending a preliminary meeting of representatives from all interested concerns, held at Plymouth, to consider the linking-up of electricity supply works in Devon and Cornwall. The counties were divided into four areas. The general opinion was that the outlay could not be borne by the works themselves; the scheme must be State-aided. It was decided to go thoroughly into the matter and prepare a scheme with all necessary details. Torquay, Exeter, Plymouth, and Cornwall representatives are to collect all statistics in their respective areas and report progress to Mr. E. G. O'Kell, of Plymouth, chairman of the Committee.

Electrical Incubation of Eggs.—A recent article in the *Journal of Electricity* gives some particulars relating to the use of electrical incubators in Western America. The superiority of electricity for heating is said to be quite obvious to anybody familiar with the poultry business, and a vast field of enterprise is being opened up for manufacturers and electric suppliers in the areas concerned. In one small Californian town about 10,000,000 chickens are artificially hatched each year, and the hatching and brooding of these chicks by electricity would require about 3,000,000 KW.-hours per annum. A single-deck incubator is provided with an average of 75 watts heating capacity per 100 eggs; the average energy consumption is given as about 10 KW.-hours per 100 chicks hatched out, and such incubators are built for from 30 to 1,200 eggs. The incubators are doubled-walled, heat-insulated, and provided with wood or metal trays about 4 in. from the bottom. The heating elements are usually at the top, but in double-deck constructions may be top and bottom.

The single-decker is claimed to give more uniform heating, but the double-decker requires less energy per egg. The space below the tray forms the nursery for the newly-hatched chicken, into which the latter drop when they break through the shell, and it is maintained at about 95° F. The thermometers have to be high-grade instruments, as a slight error may considerably influence the success of the hatch. The thermostats used are very sensitive, and will maintain the temperature to ¼° or ½°.

In operation, the eggs are placed on the trays at an angle of about 45°, small ends down; the temperature is gradually raised to 102° F., and maintained so for four to six days, when a test for fertility is made by holding the trays of eggs up to the light. A similar test is made about the 14th day. After the first test the temperature is raised to 103° F., and continued until the hatch is off. After 72 hours the eggs are cooled daily, by removing the trays for from half to two hours, down to human body temperature, and are turned to a different angle. By the 18th day the air cell in the large end should be dried down to about 30 per cent. of the total volume of the shell; ventilation will hasten drying or the introduction of moisture delay it. After the 18th day the incubator is closed until the chicks emerge and fall below the tray, where they are left for 24 hours before removal to the brooders. The electric incubator has many obvious advantages over one depending on combustion, and turns out more vigorous broods and a higher percentage of chicks than other types. At 1d. per unit its approximate cost for energy is stated to be equal to oil at 10d. per gallon, but its greater efficiency in use offsets any slight extra cost for heat.

Under-Water Coal Storage.—A recent issue of the *Electrical World* described the concrete basin constructed by the Duquesne Light Co., of Pittsburg, in which 100,000 tons of coal will be stored under water. The basin is 791 ft. long, 25·5 ft. deep, and 153 ft. wide, and is made of 40 ft. × 50 ft. reinforced concrete slabs, laid so as to permit of expansion and contraction—the expansion joints being made waterproof with pitch and tar paper, and suported on concrete strips 4 ft. wide and 12 in. thick. Water is pumped in through a 14-in. pipe leading to four 12-in. outlet pipes at different points, which discharge at 6 ft. below the top of the tank. Four 18-in. pipes running from the bottom of the tank discharge the tank water to the adjoining river, and travelling cranes spanning the tank will handle the coal.

Volunteer Notes.—First London Engineer Volunteers.—Headquarters: Balderton Street, Oxford Street, W.

March 12th.—Technical for Platoon No. 9, at Regency Street. Squad and Platoon Drill, Platoon No. 10. Signalling Class. Recruits' Drill, 6.30—8.
March 14th.—Instructional Class, 6 15. Platoon Drill, Platoon No. 2
March 15th.—Platoon Drill, Platoon Nos. 5 and 6. Ambulance Class by M.O., 6.30.
March 16th.—Technical for Platoon No. 10, Regency Street. Squad and Platoon Drill, No 9. Signalling Class. Recruits' Drill, 6.25—8.25.
March 17th.—Commandant's Parade, 2.45, Uniform, for Route March. Bugles and Drums to attend.
March 18th.—Special work at Bombing School. Parade Clapham Junction Station (City & S.L. Tube Ry.), 9.45 a.m.

(By order), Macleod Yearsley, *Adjutant.*

Registering Electrical Contractors in Mysore.—Some further particulars concerning the prompt steps taken by the Mysore Durbar to control the uses of their electric current in Bangalore and Mysore show that it is the intention of the Electricity Department in future to refuse to supply current to any lighting or power installation in those cities and in the civil and military station of Bangalore, unless such installations have been carried out by a licensed contractor. Public advertisements will shortly appear on the subject. Contractors who are not subjects of H.H. the Maharajah, will, therefore, be separately licensed for the station, and the names are given of the following contractor firms to whom it is intended to issue licences:—In Bangalore Station, the Anglo-American Electrical Stores, Campbell & Sons; in the city, G. L. Narnappa and the Empire Stores; and in Mysore City, Gajaraja Moodeliar. The fee to be paid upon securing licences is Re. 1, the object being not to secure revenue therefrom, but to make certain that electrical contractors have sufficient technical qualifications and financial resources to ensure that their work will be satisfactory, and, as far as possible, to prevent defective installations and personal injury. The draft licence recites that it is issued upon the understanding that the holder agrees to conform to the rules already in force and those which may hereafter be promulgated for regulating the supply of power for heating, lighting, and industrial purposes, and that it will be liable to be cancelled at the option of the chief electrical engineer for bad work or the violation of any of the rules.—*Indian Engineering.*

The Cost of Coal in U.S.A.—Discussing this subject at the American Mining Congress, Messrs. G. O. Smith and C. E. Lesher, of the U.S. Geological Survey, suggested that in the whole field of productive business, the coal industry seems to be the one most likely to be threatened with Government operation. Royalties add considerably to the cost of coal; in a recent lease by a large coalowner, a payment of 27 per cent. of the selling price is demanded. The average rate of royalty on anthracite is from 12 to 14 per cent. of the selling value at the mine; the minimum rate (about 10 per cent.) is found in some old leases, and the maximum (20 to 27 per cent.) in leases made during the last five years. The tendency is still upward. On one large estate, the gross return is over 2s. a ton; the value of anthracite lands, which in 1875 was £100 an acre, is now about £600 an acre. Large areas of land bearing bituminous coal, but without railway facilities, can be purchased at low prices, and the average royalty on bituminous coal is about 4 per cent. of the selling value at the mine, though in exceptional cases, where the coal is of special quality or favourably situated, royalties are much higher. The authors appear to regard with favour the principle of State control, not only of mining costs and transportation, but also of the prices charged by coal owners, in the shape of royalties.—*Electrical Review and Western Electrician.*

The Training of Disabled Men as Sub-Station Attendants.—The Queen visited on February 21st the classes in progress at the Northampton Polytechnic Institute, Clerkenwell, E.C., for giving a preliminary training to disabled sailors and soldiers as electricity sub-station attendants. Her Majesty was received by Mr. L. B. Sebastian and Dr. R. M. Walmsley, respectively chairman and principal of the Institute, with whom, among others, were Mr. C. H. Wordingham (vice-president I.E.E.) and Mr. P. F. Rowell (secretary I.E.E.), representing the Institution of Electrical Engineers (in the unavoidable absence of the president, Mr. C. P. Sparks), Mr. F. M. Denton and Mr. S. D. Chalmers (heads of the Electrical Engineering and Optical Departments), and Mr. G. R. Buckley and Miss Collin (honorary secretaries of the Disabled Soldiers' Aid Committee). During the course of a prolonged inspection of the men, while under actual instruction in the power house of the Institute, Her Majesty showed the greatest interest in the work that was being done, and made personal inquiries from each man as to his disablement and the progress he was making in his training. Her Majesty also inspected the optical workshops of the Institute.

Electroculture at Hereford.—The Development Commissioners have, with the sanction of the Treasury, decided to undertake electrocultural experiments on a practical scale at Hereford. For this purpose some 50 acres are to be provided with suitable equipment, at the Huntington Court Farm. The work will be supervised by Prof. Blackman (of the Imperial College of Science and Technology) and Mr. Ingvar Jorgensen (who recently contributed an article on this subject to our pages); Mr. W. Duddell (Government Board of Inventions, &c.) will advise on electrical matters, and Mr. W. T. Kerr, the city electrical engineer of Hereford, is also giving practical assistance, the subject being one to which he has personally given much attention, as also to the general use of electricity in farming.

Official List of Vehicle-Charging Stations.—The Electric Vehicle Committee has issued an official list of charging stations, at which batteries of electrical vehicles can be charged. This contains, roughly, 180 names of places, together with a variety of other information in regard to charging facilities, tariffs, &c. The list is being published in full in the forthcoming second edition of the "Commercial Motor Users' Association Handbook of Approved Depôts"; it will also be published as a supplement to the June issue of *The Electric Vehicle.*

Fatality.—At the inquest into the death of a man killed at the Derby Corporation Electricity Works through scalding due to explosion of a boiler tube, Mr. T. P. Wilmshurst, the engineer, said that this was the first fatality at the works in the 24 years of its existence. The boiler in question was installed in September, 1914, and had been tested periodically by the insurance company, whose report of October, 1916, contained no reference to defects. The representative of the makers said that the tube which burst had probably been overheated, but a flange pipe engineer who also gave evidence did not think so. He said that the tube generally was ·175 in. thick, but at the point of fracture it was only ·125 in., which was too thin for the pressure. He thought it very unlikely that the fault would have been discovered by any examination or test. Verdict, "Accidental death."

The Electro-Harmonic Society.—The last smoking concert of the season will be held at the Holborn Restaurant, in the Venetian Chamber, on Friday, March 16th, commencing at 8 p.m. Mr. A. M. Sillar will be in the chair. Programme:—Mr. Gwylim Wigley, tenor; Mr. S. H. Beebe, baritone; Mr. Robert Howe, bass-baritone; Mr. Will Edwards, humorist; Mr. Walter Montague and Mr. Ben Osborne, humorous sketches; Mr. Selwyn Driver, entertainer at the piano; Mr. Bernard Flanders, A.R.A.M., pianoforte solo and accompanist.

New Zealand.—A Christchurch agent, having considerable relations with the leading engineering firms in New Zealand, wants to get into touch with British manufacturers of electrical goods and general engineering supplies. Particulars can be obtained from the Board of Trade Department of Commercial Intelligence. Reference number 111

Automatic Train Control.—A system of automatic control of trains, by which the brakes are applied when an engine-driver passes a signal at danger, is strongly advocated by two Board of Trade Inspectors, Colonel Pringle and Lieut.-Colonel Druitt, in their reports on collisions which occurred on December 19th near Kirtlebridge, on the Caledonian Railway, and at Wigan, on the London and North-Western Railway. In both cases snow was falling.—*The Times.*

German Professors in England.—The *Morning Post* states that on Tuesday the Birmingham City Council decided to withhold the annual grant of £13,000 to Birmingham University until the latter had decided not to retain the services of any pre-war unnaturalised German professor on its salaried staff. The mover urged that German professors were largely responsible for the policy of blood and iron. It was stated that the professor to whom the resolution related had been in this country for 20 years, but only became naturalised in September, 1914. An amendment by the Lord Mayor to reduce the grant by the amount of the professor's salary was rejected.

Tungsten from Cornwall.—Wolfram, the ore from which tungsten is derived, is being mined in Cornwall, near Tavistock, where it is found in conjunction with tin ore (cassiterite). Formerly the wolfram was carefully picked out by hand and rejected, whereas nowadays it is the miner's main quest, and the old wolfram dumps have proved rich sources of tungsten. According to a correspondent of the *Times*, a stamp mill on the river Tamar is being reorganised, and part of it is at work, the motive power being electrical. Magnetic separators are employed to separate the wolfram from the cassiterite, the former being slightly magnetic.

Summer Time.—The Committee appointed by the Home Secretary to inquire into the results of the Summer Time Act, 1916, has recommended its renewal "in 1917 and in subsequent years," and that it shall operate from the second Sunday in April to the third Sunday in September, the variation from normal time being one hour. Inquiries made by the Committee show that the moral and physical effects of the Act last year were good, and the opinion is expressed that nearly the whole trouble of those who found it irksome to get up in the early mornings last summer was their failure to go to bed at the same hour by the clock as at other times of the year. The great bulk of the working classes were favourable to summer time. The opinion of the very large majority was that the children benefited by summer time, though in certain districts children did lose sleep.

The opinions of agriculturists regarding the working of the Act were extremely conflicting, but the advantage of having an extra evening hour for carrying crops outweighed any inconvenience.

On many farms and in some entire districts—so far as the agricultural community was concerned—the Act was not observed at all. Farmers and others refused to alter their clocks. Therefore, in the same neighbourhood old time was observed on farms and summer time in schools, post offices, railway stations, and similar places. This caused confusion and friction. However, a very large majority of farmers are in favour of the renewal of the Act.

Artificial light had to be used in Lancashire weaving sheds in the early mornings during the second half of September, and the light raised the temperature in the sheds to such a degree that operatives refused to work in them. September of last year happened to be a cool month; in a warm September the difficulty would be increased. This difficulty would appear to be met by the recommendation that the date for reversion to normal time should be earlier than that adopted last year.

The Stock Exchange Committee drew the Committee's attention to a difficulty which in normal times might cause considerable inconvenience. Before the war, the last hour during which the London Exchange was open (3—4 p.m.) overlapped the first hour (10—11 a.m.) of the New York session, and during this hour in normal times a vast amount of business was done, and was often continued in the street after the London Exchange had closed. At the present time, the London Exchange closes at 3 p.m., but after the war, when normal conditions are restored, the importance of coincident periods in the two sessions may possibly be still greater than in former times. The Committee believes that this difficulty is capable of adjustment between the London and New York Exchanges without serious inconvenience to members and clerks.

With regard to the current daily work of the Meteorological Office, the director, Sir Napier Shaw, reported that the inconveniences were, as far as possible, overcome. A great deal of confusion arose with the observers, and the continuity of many series of observations had been interrupted. "My impression is," says Sir Napier Shaw, "that there is now no possibility of placing beyond dispute the exact time of any event, except those dealt with by telegraph, which occurred between May 21st and September 30th."

Taking the evidence as a whole, the Committee says that the vast preponderance of opinion throughout Great Britain is enthusiastically in favour of summer time, and of its renewal as a permanent institution. Further, the Committee believes that what opposition still remains will completely disappear in a few years.

American Electric Vehicle Trial.—The new model of an electric passenger vehicle, manufactured in Detroit, in a recent run from New York City to New Haven, Conn., made a highly commendable record. The Electric Vehicle Section, N.E.L.A., has been advised that three passengers were carried, and the distance of 88·2 miles from Columbus Circle, New York City, to the Hotel Taft, New Haven, Conn., over an extremely hilly, although smoothly constructed road, was accomplished in 3 hours and 45 minutes, including all stops, traffic delays, and reduction of speed through thickly populated centres, and on a single charge of the battery. While an average speed of 23·4 miles per hour over a distance of 88·2 miles may not arouse the interest of the speed fiend, yet when it is remembered that this is kept up over average roads, the speed is about as great as can be maintained by either a petrol or electric car with comfort to the riders, and with safety to pedestrians.

This new model is furnished with a control system which provides for the safety of the driver and other occupants. It consists of an automatic device which, by the pressure of the foot on a pedal, even though the car is travelling at full speed, instantly cuts off the current and applies both brakes, regardless of the position of the control lever. It is impossible to start the car again until the control lever has been returned to the neutral position.

This run is an evidence of the "electric's" ability to make an average long run, covering the ground at a comfortable speed, with the fear of possible breakdowns practically eliminated. A series of runs have recently demonstrated the fact that an electric automobile can be very satisfactorily used for interurban travel. These runs averaged distances of about 90 miles per trip, and were conducted with absolutely no trouble of any sort. One of the longer runs was from Chicago to Milwaukee, a distance of 101 miles.

Prohibited Exports.—The Supplement to the *Board of Trade Journal* of March 8th contains complete lists of articles which, according to the latest information received by the Board of Trade, are prohibited to be exported from Norway, Portugal, Russia, Spain, Sweden, and Switzerland. The Supplement also contains the United Kingdom Contraband List in its present form.

Institution and Lecture Notes.—Institution of Electrical Engineers.—The members of the Dublin Local Section recently attended a gas furnace and industrial heating exhibition, organised by the Alliance and Dublin Gas Co., and listened to an address on "Industrial Heating," by Mr. H. F. Cotton, the company's distribution engineer.

The Society of Engineers (Inc.).—Since reinforced concrete was introduced into this country, it has been customary to employ plain round mild steel bars, but Mr. A. W. C. Shelf, in a paper on "High Tensile *versus* Mild Steel for Reinforced Concrete," read before the Society on Monday last, endeavours to prove that greater efficiency and economy is obtained by physically developing mild steel bars, for the purpose of taking out the first yield in the steel, which is useless, and has a detrimental effect in concrete. When this first yield or stretch is taken out, a higher yield point is obtained without any injury to the steel, so that it is safer to employ a stress of 20,000 lb. per sq. in. (which results in a saving of 20 per cent. in the weight of steel required) than it was to employ a stress of 16,000 lb. per sq. in. before the steel was physically developed.

Junior Institution of Engineers.—A lecturette was given by Mr. C. G. D. Burdett on February 23rd, entitled "Random Notes on Structural Design." The author dealt with such details as uniform pressure upon footings, the load over lintels, roof trusses, bridge girders, &c. The question of wind pressure was also discussed.

The Employment Exchanges.—The Minister of Labour has appointed a Committee to advise and assist the Employment Department of the Ministry upon matters affecting workmen in the building trades in connection with the working of employment exchanges. Mr. J. Kinniburgh is to represent the electricians.

It is proposed, in due course, to take steps with a view to forming a corresponding Committee of employers' representatives in the building trades.

Bankruptcy Proceedings.—Canadian interests in electric lighting and power and in pulp and paper mills were the principal features in the estate of Mr. A. B. Craig, woollen merchant, trading at 8, Well Street, Cripplegate, E.C., under the style of John Craig & Sons. The debtor failed in the London Bankruptcy Court in November, 1915, and on the 7th inst. he applied to Mr. Registrar Hope for an order of discharge. In the opinion of the Official Receiver, the debtor's estimate of the realisable value of his Canadian interests was excessive and unwarranted; they were very involved, and nothing could be done towards their realisation until after the war. Up to the present time the trustee had only received £1,082 in respect of the assets. The hearing was adjourned.

Charles Benjamin Ogilvie, electrical engineer, 43, Dudley Road, Whalley Range.—The adjourned public examination of this debtor was held on March 6th at Salford, when the debtor attributed his failure to lack of capital and the non-success of a partnership business. The deficiency in the matter was just over £140. After his apprenticeship he started for himself on a small scale as an electrical and mechanical engineer at Dudley Road. He had no capital, but managed to make a living until he was joined by three friends, with a view to undertaking work for the Government. A small sum was subscribed and certain orders were executed, but owing to lack of capital the partnership was not a success, though there were no outstanding liabilities in respect of it. The examination was concluded.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station and Tramway Officials.—The Halifax Tramways and Electricity Committee has resolved to increase the salaries of the electrical engineer (from £700 to £800), the traffic manager (£400 to £425), and the tramway engineers (£300 to £325).

The L.C.C. on Tuesday approved the appointment of Mr. J. K. BRUCE, deputy chief officer of the tramways, as traffic manager under the new scheme.

The wages of the shift engineers of the Batley electricity department have been increased to £2 2s. per week of 56 hours.

Increases of salary have been granted by the Dewsbury Council to Mr. R. H. CAMPION, electrical engineer, from £400 to £425, and to the assistant engineer, Mr. R. W. GRUBB, from £200 to £250 per annum.

Consequent on Mr. W. J. Carter, chief assistant engineer (Batley electricity department), having resigned, Mr. PERCY MARSH MAXWELL, shift engineer, was appointed mains superintendent at a salary of £130 per annum; and Mr. ALBERT RUSSLING, shift engineer, was appointed station superintendent, at £125 per annum.

The Manchester Corporation Electricity Committee has recommended that the salaries of the undermentioned officials be advanced:—

Mr. H. C. Lamb, resident engineer at Stuart Street generating station, first year £500, second year £550, third year £600.
Mr. F. T. Guildford, chief works clerk, Dickinson Street, at £200, to be appointed engineer's secretary, at £250.
Mr. F. A. Fothergill, foreman fitter, Stuart Street, at £200, to be appointed mechanical engineer at £250.
Mr. T. Baxendale, assistant resident and constructional engineer, Stuart Street, from £300 to £350.
Mr. J. R. Davidson, boiler-house engineer, Stuart Street, from £225 to £275.
Mr. H. W. Smyth, engineer-in-charge, Stuart Street, from £225 to £245.
Mr. W. H. Simpson, engineer-in-charge, Stuart Street, from £220 to £240.
Mr. W. H. Woods, engineer-in-charge, Stuart Street, from £220 to £240.
Mr. A. L. Lunn, engineer-in-charge, Stuart Street, from £200 to £240.
Mr. J. G. Thomson, boiler superintendent, Stuart Street, from £200 to £225.
Mr. W. Baxter, foreman of electrical repairs, Stuart Street, from £175 to £200.
Mr. J. Grey, clerk of the works, Stuart Street, from £163 16s. to £175.
Mr. W. Dundas, resident engineer, Dickinson Street and Bloom Street stations, from £325 to £375.
Mr. A. Williams, Mr. A. E. Hinde, Mr. F. P. Seager, and Mr. J. A. Vice, engineers-in-charge, Dickinson Street and Bloom Street stations, from £200 to £220.
Mr. J. A. E. Hilton, relief engineer-in-charge, Dickinson Street and Bloom Street stations, from £156 to £175.
Mr. T. H. Wray, foreman fitter, Dickinson Street and Bloom Street stations, from £190 to £200.
Mr. H. W. Sanders, chief draughtsman, Dickinson Street, from £260 to £275.
Mr. W. Kidd, assistant constructional engineer, Dickinson Street, from £200 to £225.
Mr. A. Lee, senior draughtsman, Dickinson Street, from £163 16s. to £185.
Mr. R. F. Paiton, technical assistant engineer, Dickinson Street, from £163 16s. to £175.
Mr. J. Clark, assistant mains engineer (low-tension), from £275 to £300.
Mr. H. Hawkins, assistant mains engineer (high-tension), from £275 to £300.
Mr. P. T. Fowler, fault assistant engineer, from £210 to £230.
Mr. A. J. Lovell, district assistant engineer, from £200 to £220.
Mr. E. Bolton, sub-stations engineer, from £200 to £225.
Mr. W. H. Hanstock and Mr. W. Hutchinson, sub-stations superintendents, from £175 to £200.
Mr. R. Swettenham and Mr. J. H. Whiteley, sub-stations inspectors, from £163 16s. to £175.
Mr. H. A. Ratcliff, general superintendent of testing, standardising and scientific department, from £350 to £400.
Mr. O. Howarth, senior assistant in testing, &c., department, from £163 16s. to £185.
Mr. G Fry, superintendent, motor section, from £163 16s. to £185.
Mr. J. A. Cookson, mains surveyor, from £425 to £450.
Mr. C. H. Rayner, assistant mains surveyor, from £205 to £225.
Mr. L. H. Marlor, installation inspector, from £245 to £270.
Mr. G. A. Proctor, technical assistant to mains surveyor, from £163 16s. to £180.

The Islington Lighting Committee recommends that the salary of Mr. A. P. MACALISTER, deputy electrical engineer, be advanced from £350 to £400; and that the salary of Mr. C. S. A. MUNRO, constructional and repairs engineer, be increased from £3 9s. to £4 per week.

The Islington B.C. Special Salaries Committee has considered a petition by six members of the electricity works technical engineering staff, pointing out that, as single men, they are excluded from participating in the war bonus scheme, notwithstanding that during the war their duties have increased nearly two-fold, mainly owing to the increased station output, and they are not in receipt of any pay for overtime or extra duties. The officers concerned had applied for permission to join the Forces, but they had been informed that they were best serving the national interests by remaining in their present positions. The Committee is satisfied that the men are engaged on very important work, and it has decided that the war bonus scheme should be applied in their case.

Mr. F. E. A. REA, engineer-in-charge at the Rawtenstall electricity works, was presented with a case of cutlery by the staff on the occasion of his marriage.

General.—Coun. RICHARD HOLT has been appointed chairman of Blackpool Electricity Committee, in succession to the late Ald. J. Brodie.

Mr. I. J. GOWEN, A.M.I.E.E., late of Stoke-on-Trent Borough electricity department, and formerly chief assistant engineer to the Rangoon Tramways & Supply Co., has been appointed chief engineer to Messrs. Portals.

Roll of Honour.—Private J. KENYON, Loyal North Lancashire Regiment, who has been killed in Mesopotamia, aged 27, was employed by Messrs. Dick, Kerr & Co., Ltd., at Preston.

Private J. F. NEAL, Royal Marine Light Infantry, who was with Messrs. Johnson & Phillips, Ltd., of Charlton, has died of wounds.

Private J. DUNN, Machine Gun Corps, who was for five years on the staff of Messrs. Willans & Robinson, Rugby, has died in hospital after having his leg amputated.

Private L. J. HOPKINS, who was at Rugby with the British Thomson-Houston Co., Ltd., has fallen in action.

Lieutenant W. R. CARSE, R.F.C., who has been killed whilst flying, was on the test department staff of the B.T.H. Co., Ltd., at Rugby.

Sergeant J. E. WOLSTENCROFT, King's Own Yorkshire Light Infantry, formerly on the Hull Corporation tramway staff, has been recommended for a commission, and is now in the Officers' Training Corps.

Obituary.—MR. JAMES FORREST.—We regret to record the death, which occurred on Friday last, at the age of 91 years, of Mr. James Forrest, the honorary secretary of the Institution of Civil Engineers, with which he had been connected for 75 years, and to the interests of which he had unreservedly devoted by far the greater part of his life. Mr. Forrest, who was a Londoner by birth, received his engineering training under Messrs. E. & J. Manby, to whom he was articled, and later under Mr. Charles Manby, the then secretary of the Institution. Some years of practical railway construction experience in Yorkshire followed. Mr. Forrest returned to London in 1848, and was with Mr. Manby assisting him in the work of the Institution, but receiving no remuneration excepting an honorarium of £50 for compiling a library catalogue. In 1856 Mr. Manby retired from the active secretaryship, but he retained the title for three years from that date. The full title and responsibility fell to Mr. Forrest in 1859, and from that date onwards he devoted himself entirely to the Institution's interests until ill-health compelled him to retire from active work in 1896. At that date he was made honorary secretary. It was due to his efforts that the Council was induced to abandon the former rigid exclusiveness of the body, which had so limited its membership that it could not recognise as a civil engineer a man who was occupied in the design and construction of machinery. One of the effects of this exclusiveness was seen in the formation of the Institution of Mechanical Engineers. Mr. Forrest's ambition was for the "Civils" to become the representative body of the entire engineering profession of the British Empire. The realisation of such an ambition under the circumstances could not be secured without patience, tact, and hard work, and it was not until the year 1886 that he could claim to have thoroughly established the new reputation. When the deceased gentleman was first appointed secretary, there was a membership of only 835 in all classes; to-day, including students, it is 8,600. The "James Forrest" Lecture, of course named after him, was established by the Institution out of a fund subscribed by members in his honour, and presented by him for that purpose. Sir J. Wolfe Barry is shortly to deliver the 25th of these lectures. A service in memory of Mr. Forrest was held at St. Margaret's Church, Westminster, on Wednesday.

MR. E. M. MURPHY.—Mr. Edward Martin Murphy, who has passed away in his 35th year, was the fourth son of Mr. W. M. Murphy, chairman of the Dublin United (Electric) Tramways Co. He spent his early years at the General Electric Works, Schenectady, where he received his training in electrical engineering. Of late years, deceased had been managing director of the *Independent* Newspapers, Ltd., Dublin, of which his father is chief proprietor. Mr. Murphy had been in bad health for a considerable time, and his death was not unexpected.

SIR BENJAMIN BROWN.—We regret to record the death of Sir Benjamin Brown, who had been for the whole of his life so prominently associated with engineering industry in the Newcastle district. Sir Benjamin, who was 78 years of age, retired from the chairmanship of Messrs. R. & W. Hawthorn, Leslie & Co. only last year. He was a director of the Newcastle & District Electric Lighting Co., Ltd. As our readers are aware, he was very keenly interested in industrial labour problems and the relations of Capital and Labour. He was a writer on this matter almost to the last. We read that Sir Benjamin did not hesitate to ascribe much of his success in industry to the timely advice and support of a banker of last century, who, at the age of 30, influenced his mind and activities in the direction of the business side of engineering.

NEW COMPANIES REGISTERED.

Tingey & Co., Ltd. (146,292).—Private company. This company was registered on March 1st, with a capital of £1,000 in £1 shares, to take over the business of engineers carried on by L. I. Robinson and W. H. Tingey, at Eyre Street, Clerkenwell, and at 3, Staple Inn, E.C., as Tingey & Co., and to carry on the business of mechanical, electrical, experimental, and scientific engineers. The subscribers (each with one share) are: L. I. Robinson, 3, Staple Inn, W.C., electrical engineer; W. H. Tingey, 63, Chancery Lane, W.C., engineer. The first directors are L. I. Robinson and W. H. Tingey. Registered office: 3, Staple Inn, Holborn, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Walter's Electrical Manufacturing Co., Ltd.—A memorandum of satisfaction in full on January 1st, 1917, of charge dated September 29th, 1916, securing an undefined amount.

Phillips Magnetos, Ltd.—Particulars of £3,000 debentures created October 2nd, 1916, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the whole amount being now issued. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Sterling Telephone & Electric Co., Ltd.—Memoranda of satisfaction in full (*a*) of mortgage dated February 8th, 1915, securing £10,000, and further advances, and (*b*) mortgage dated November 11th, 1915, securing £48,253 17s. 1d. and further advances (notice filed February 22nd, 1917), have been filed.

Horrabridge & District Electric Supply Co., Ltd.—Particulars of £400 debentures created January 29th, 1917, filed pursuant of Section 93 (3) of the Companies (Consolidation) Act, 1908, the whole amount being now issued. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

CITY NOTES.

Liverpool Overhead Railway Co.

At the annual meeting on February 27th, Mr. H. C. Woodward said that the railway was still controlled by the Railway Executive Committee. The receipts shown (£105,526) did not represent the traffic actually carried, but that was the sum they received after the surplus over their 1913 revenue had been paid to the Government. The traffic continued to expand. The total expenditure on the railway and tramways amounted to £73,394, an increase of £13,359. This was due to the higher prices of coal, and stores and materials of every description, and additional war bonus. The upkeep of the railway and tramway had been maintained in as efficient a condition and state of repair as was possible under existing circumstances, but certain arrears would have to be made up immediately opportunity again offered, for which they expected to be recompensed by the Government. They carried last year 3,500,000 more passengers than in 1913, with about the same train mileage, and this larger traffic had considerably taxed the accommodation of their rolling stock, particularly at certain times of the day. They ran a three-minutes' service in the busiest hours, which was as much as they could do with their present staff; but, even then, there was much congestion, which the directors had endeavoured to meet by purchasing some additional coaches, so as to give more third-class accommodation. In common with other railways, they had, on the instructions of the Government, increased their ordinary fares by 50 per cent., which increase came into operation on January 1st last. The directors communicated with the Board of Trade, asking that the increase should not apply to their system, as, being worked by electricity, they had no locomotives to hand over nor rails to spare, like other railways. The Liverpool Chamber of Commerce joined in this appeal, but the reply, in both cases, was that no distinction could be made, and that the increase should operate on all railways under their control. When the war was over, and the present Government control and guarantee terminated, they would undoubtedly find themselves faced with a largely increased working expenditure, and although he should be very glad to see their fares again on a lower level, and traffic thus encouraged, he doubted their being able to return in all cases to the extremely low rates in vogue during the pre-war period. The chairman congratulated the general manager, Mr. Neachell, his principal assistants, and the staff as a whole, on the successful carrying on of the undertaking, with a much increased traffic, amounting, as compared with 1913, to an increase of about 26 per cent., and with so many comparatively new hands to train and instruct in their duties.

Westminster Electric Supply Corpn., Ltd.

Mr. J. Browne Martin presided at the annual meeting on February 28th. He said that the receipts were £15,000 larger than for 1915, owing to the increased charges to consumers and large expansion in power and heating current sold. The use of radiators and electric fires was constantly increasing. They had sold 187,000 units less for lighting than in 1915, and still less would have been used but for the fogs and dark weather. Power and heating units sold increased by 1,200,000, and the total for these purposes very nearly approached those sold for lighting. In regard to expenses, coal had cost 1s. 6d. per ton more than in 1915, and the cost of public lighting was up by £927, owing to carbons and wages. For the first time they had a material reduction in the amount paid for rates. They had lent to the Treasury securities to the amount of over £70,000, and held £90,000 of War Loan Exchequer Bonds and Treasury Bills. They had also subscribed £25,000 to the new loan. The Daylight Saving Bill appreciably reduced their lighting sales. They were making no further increase in the charge for electricity for lighting purposes beyond the 10 per cent. of October, 1915, but they were slightly raising the price for that supplied for power and heating, which was still appreciably below that charged in many other districts. The price of coal and its delivery formed a chief factor in the business, and those contingencies must be borne in mind.

Tramways, Light & Power Co., Ltd.

Viscount Chilston presided at the annual meeting on February 28th. He said that their income from the various power, lighting, and tramway undertakings was £35,272, an increase of £4,780. Administration expenses were approximately the same as in 1915, but debenture and loan interest absorbed £1,200 more. £100,000 of 5 per cent. debenture stock was issued during the year, the proceeds of the issue being applied in repaying loans from bankers and providing for the current needs of the company. All the properties showed an improvement except the electric lighting portion of the Leamington and Warwick Co., and the electric lighting undertaking in Leamington. The decline in profit was purely temporary. The position of the company now justified them in paying dividends half-yearly on September 1st and March 1st each year, and they therefore proposed to pay the preference dividend on these dates in future, unless the company was faced with any set-back which could not be foreseen at present. Out of the balance of £36,769 available, £12,214 was required for debenture and loan interest, 6 per cent. was paid on the preference shares, £5,000 transferred to reserve, and £4,073 is to be carried forward. Considering the great difficulties of the times, the report was extremely satisfactory.

Newcastle and District Electric Lighting Co., Ltd.

At the annual meeting, on March 2nd, Mr. Arthur Scholefield, the chairman, referred to the great loss that the company and the whole of the Tyneside district had sustained through the death of Sir Benjamin C. Browne. Sir Benjamin joined the company 28 years ago, when it was formed. The directors proposed to place £10,000 out of the year's profits to the reserve fund, making £20,777. The capital expenditure had been increased by £9,793. The gross receipts for energy, &c., showed an increase of £15,051, or about 19 per cent., which was very good; the receipts had been affected by the lighting restrictions. On the termination of the war the loss due to the restriction of lighting would be recovered, and with a reduction of working costs the directors looked forward with confidence to the results of the future. There had been an increase of 23 per cent. in the number of units sold during the year. The net profit for the year, £20,816, was an increase of £4,851. They proposed to pay a dividend of 2½ per cent., for the directors, in view of the continued high price of coal and the unsettled conditions prevailing at the present time, did not think it would be wise to distribute more than the dividend now recommended.

Kensington and Knightsbridge Electric Lighting Co., Ltd.

During 1916 connections to the system increased by 59 to 5,070, and the energy-consuming devices by 11,390 (30 watts) to 522,175. Lighting restrictions were more stringent than in 1915, and the Summer Time Act caused a reduction of 8 per cent. in the units sold during the period it was in operation. The net profit was £11,574, plus £432 brought forward. After paying the preference dividends, and a final dividend at the rate of 7 per cent. for the last half-year on the ordinary, making 6 per cent. for the year, £205 is to be carried forward. The balance of the renewal and reserve fund account, after writing off the capital account £6,981 for old plant sold, now stands at £135,925. Mr. G. H. Hopkinson has retired from the board after 23 years. The vacancy is not to be filled at present. Annual meeting: March 15th.

Metropolitan Electric Supply Co., Ltd.

The capital expenditure during 1916 was £34,493, making the total £2,293,094. The gross revenue was £277,909, an increase of £48,708; the working expenses were £161,009, an increase of £33,859. £40,000 has been put to depreciation and reserve (now standing at £377,359), and £76,900 is carried to the credit of net revenue account. The balance brought forward, together with interest and dividends on investments, &c., brings the total up to £90,195, and after deducting interest on debenture stocks and loans, dividend on preference shares and sundry items written off, the balance is £34,757. A further dividend of 2s. per share (at the rate of 4 per cent. per annum), making a total for the year of 3s. per share, or 3 per cent. for the year, is recommended, leaving £4,757 to carry forward. The new connections during the year were equal to 119,880 25-c.p. lamps, making the total connected 1,317,643. Annual meeting: March 13th.

County of London Electric Supply Co., Ltd.

The capital expended during 1916 was £31,409, making £2,189,064. The revenue for the year, after deducting all costs and charges, was £156,894, plus £14,499 brought forward. Debenture and loan interest absorbed £42,528, and there is put to reserve for depreciation £45,000, leaving for distribution £83,865. After paying the preference dividend, and dividends of 5 per cent. and 9 per cent., less income-tax, for the first and second half-years respectively on the ordinary shares, £18,378 remains to be carried forward. Applications for 4,516 kw. received during the year bring up the total to 64,581 kw. The total units sold were 35,029,862, an increase of 4,467,817. The number of consumers increased from 25,913

to 26,994. The results are regarded as satisfactory. Cost of coal and other material further increased; lighting restrictions more vigorously enforced. The Bournemouth & Poole Co. has paid 6 per cent. for the year. Coatbridge & Airdrie Co. increased its units sold from 6,134,986 units to 8,414,823. Annual meeting: March 12th.

South Metropolitan Electric Light & Power Co., Ltd.

Mr. H. ST. J. WINKWORTH, presiding at the annual meeting, said that the number of new consumers was only 204, as cable extension had been kept to a minimum in residential and shopping districts. New business and extensions, and additional bulk supply had increased the revenue by £15,130, the largest increase they had had. The total units sold were 41 per cent. better than 1915, and 94 per cent. better than 1914. Sales for heating and domestic power were 356,758 units, as against 212,154 in 1915. Sales in the showrooms and the wiring and installation work carried out amounted to £12,800, with 4,804 transactions (4,479 in 1915). Coal cost £26,673, or £12,420 more, partly due to increased output and partly to higher cost, higher freights, and inferior quality, although owing to more efficient working the quantity used per unit generated was the lowest on record. Rates charged to consumers had been revised in some cases to meet in part the increased cost. The West Kent Electric Co., Ltd., had paid a dividend of 10 per cent., and the expansion of business was continuing, and the outlook was favourable. The prospects as to output of the South Metropolitan Co. for the coming year were good, but it was difficult to forecast what the effect of the prevailing conditions might be upon economical working. For many weeks past the increased output has approximated 35 per cent. to 45 per cent. over that of 1916. Mr. H. W. BOWDEN, the engineer-in-chief, in seconding the adoption of the report, made his usual technical statement. Among other things, he said that the results of their experiments with coke breeze were distinctly encouraging, but they had to abandon the trials owing to the heavy demands made upon the boiler plant. It was their intention to resume the trials as soon as there was sufficient boiler plant available for the purpose.

St. James' and Pall Mall Electric Light Co., Ltd.

Mr. WALTER LEAF, presiding at the annual meeting, said that by appointing Sir Alex. Kennedy to succeed the late Mr. Dobson (chief engineer) they were able to draw still closer their alliance with the Westminster Co. During the year the business had recovered from the shock of war, and resumed its normal steady progress. The output of units had grown by 600,000, almost entirely in the second half of the year, and that rate of increase was being maintained. If the present rate continued to be maintained, 1917 should easily surpass any year before the war. Their revenue also showed a good increase, chiefly owing to increased output, but partly to increased charges made to consumers. The increased cost of coal showed itself in the increased cost of electricity purchased, amounting to £7,600 more than last year. The increase would have been much larger but for the efficiency of the new plant installed by the Central Co. They had obtained a re-valuation for rating, with the result that their payments for rates were reduced by £1,398. The Central Co. had paid no dividend, so receipts from investments had fallen by £1,711. The net result was that they were enabled to pay the same dividend as last year, but it was all paid out of profits, whereas last year they had to take £4,500 from the contingency fund.

Waste Heat and Gas Electrical Generating Stations, Ltd.

Profit for year ended January, 1917, after deducting administration expenses, £40,080, against £39,819 last year; transferred to reserve, £11,500, balance brought forward, £17,430. Available profit £45,511, against £43,030 for 1915. The dividend is to be 8 per cent., as before, leaving £19,911 to carry forward. The new generating plant at Weardale power station has been delivered, and will be completed at an early date. With this plant the coke oven gas will be utilised in an internal-combustion engine, instead of under boilers as at present. The Grangetown power station extensions are now in operation. Capital expended during 1916, £37,738. The revenue from units generated at the different power stations has been satisfactorily maintained, the amount of waste heat and gas having been approximately as in 1915, but the amount is still below the average obtained prior to the war. Arrangements have been made, in conjunction with the Cleveland and Durham Power Co., under which a power station will be erected at Horden for the utilisation of waste heat and gas from coke ovens being constructed by the Horden Collieries, Ltd., and plant of 3,000 H.P. capacity will be installed.

Charing Cross, West End and City Electricity Supply Co., Ltd.

The directors report that during 1916 the West End undertakings increased their gross earnings from £138,964 to £150,473, and the expenses, excluding depreciation, rose from £70,068 to £78,831. The net earnings advanced from £68,895 to £71,642. Including balance brought forward, £18,044, and interest accrued for 1916, £3,234, the available sum is £92,920. There is absorbed by debenture interest £17,829, £22,000 is put to depreciation, the preference dividend is paid, also 5 per cent. on the ordinary shares, leaving £15,090 to be carried forward. The equivalent of 30-watt lamps connected to the West End mains is 724,418 (457,185 lighting, 42,798 heating, 224,435 (9,025 H.P.) motive power). The City undertaking increased its gross earnings from £158,357 to £176,464, and the expenses advanced from £94,590 to £110,909; the net earnings advanced from £63,767 to £65,555. After adding £18,000 brought forward, providing for debenture and loan interest, &c., and paying the preference dividend, £17,739 is carried to general reserve (income) account, and £18,000 is to be carried forward. The equivalent of 30-watt lamps on the City mains is 748,623 (319,160 lighting, 69,640 heating, 359,823 (14,470 H.P.) motive power).

West End.—Units generated, 4,152,539; bought, 11,972,745. Total sold, 11,775,521. Used on works, &c., 4,349,763. Total accounted for, 16,125,284.

City.—Units generated, 34,654,576; bought, 153,715; sold, 28,397,463. Used on works, &c., 6,410,828. Total accounted for, 34,808,291.

Northampton Electric Light & Power Co., Ltd.—During 1916 the connections were 19,596 (32-watt), making 242,853. Motors increased by 476 H.P., making 5,144 H.P., of which 3,580 H.P. is on hire. The units sold totalled 5,526,482, an increase of 9.3 per cent. Owing to the importance of extensions, the capital was increased by £50,000 in £1 shares, and the shareholders and the general public had responded entirely satisfactorily to the offer of the shares. £5,500 has been added to depreciation, and a further £925 has been written off hired motors. The reserve fund is increased by £1,000. After paying 5 per cent. on the preference shares, and 6½ per cent. for the year on the ordinary, £2,010 is to be carried forward. Mr. Brook Sampson has retired from the board, and Mr. A. H. Geldart will take his seat.

Cambridge Electric Supply Co., Ltd.—Mr. D. MUNSEY told the annual meeting, on February 28th, that the severe outside lighting restrictions had affected them adversely, but the increase in current used for power had compensated them somewhat, though the income therefrom was less. Coal cost £800 more than in 1915. Rates and taxes increased by £160. He thought that if they could pay 5 per cent. the shareholders would be satisfied. What 1917 would bring forth he could not tell. Mr. A. A. C. SWINTON, in moving the re-election of Sir C. Parsons as a director, said that Sir Charles could not be present as he was sitting as chairman of a meeting of the Board of Trade Committee on the Electrical Trades, which was concluding its report, and he could not get away. The Committee had sat weekly for many months.

Chloride Electrical Storage Co., Ltd.—According to the *Financial Times*, an extraordinary meeting is to be held on 8th inst. to consider the following resolutions: (1) That the capital be increased from £135,350 to £300,000 by the creation of 164,750 £1 shares, of which 73,250 will be ordinary shares and the remaining 91,500 may be issued with such rights as the company in meeting may determine; (2) that £73,250 of the reserve fund be distributed in the form of fully-paid ordinary shares as a bonus to holders of ordinary shares.

Tyneside Tramways & Tramroads Co.—At the half-yearly meeting, Dr. J. T. MERZ said that their receipts had been considerably more than they were in the corresponding half-year of 1915, and they were, therefore, able to make up the deficiency in the last half-year, and bring up the dividend to 3 per cent., as it had been before. Their revenue had increased £687 on the half-year, they had been working on a smaller mileage, and had gained ½d. per car mile, but the costs had gone up 0.6d. per car mile.

Jarrow & District Electric Traction Co., Ltd.—Total revenue for 1916 £8,755, a decrease of £100. After deducting expenses, debenture and loan interest, and £800 for renewals, the surplus is £2,213, plus £1,040 brought forward. £900 is placed to reserve, 3 per cent. is paid on the ordinary shares, and £855 carried forward.

Shropshire, Worcestershire & Staffordshire Electric Power Co.—An extraordinary meeting is called for March 19th, at the Electrical Federation Offices, to authorise the board to issue 50,000 of the 150,000 cum. pref. shares of £1 each created in May, 1915, as redeemable 7 per cent. cum. pref. shares of £1 each.

Stock Exchange Notice.—The Committee has ordered the undermentioned to be quoted in the Official List:—

India-Rubber, Gutta-Percha & Telegraph Works, Co., Ltd.—£400,000 5 per cent. debentures of £100 each, Nos. 1 to 4,000.

Northallerton Electric Light & Power Co., Ltd.—Mr. J. HUTTON informed the annual meeting that, owing to the war, the net profit for 1916 was only £232, against £496 for 1915.

Automatic Telephone Manufacturing Co., Ltd.—Dividend, 5 per cent. on ordinary shares; £16,000 is written off, and £14,774 is to be carried forward.

Tyneside Electrical Development Co., Ltd.—Dividend, 6 per cent. per annum on the preferred ordinary, and 10 per cent. on the deferred ordinary, carrying forward £933.

Alldays & Onions Pneumatic Engineering Co., Ltd.—Interim dividend, 5 per cent. per annum, less tax, on the ordinary shares for the half-year.

South London Electric Supply Corporation, Ltd.—Dividend on ordinary shares, 5 per cent. for 1916, carrying forward £8,053. Units sold 6,698,357, an increase of 380,217.

Rushden & District Electric Supply Co., Ltd.—The number of consumers increased from 123 to 151 during 1916. Motors increased from 292½ to 459 H.P., of which 393 is let out on hire. Units sold increased by 86 per cent. to 464,713, and revenue from £1,699 to £3,060. A dividend of 5 per cent. is to be paid, and £470 is being written off for depreciation, £164 off preliminary expenses, and £95 is to be carried forward.

Melton Mowbray Electric Light Co., Ltd.—Dividend for the year, 2 per cent., placing £800 to plant renewals reserve and carrying £395 forward. Mr. W. J. New, the chairman, said that the report was satisfactory under the circumstances, though the dividend had fallen off. No reduction in the cost of coal could be expected, and a further increase in charges to consumers at an early date must be anticipated.

Bruce Peebles & Co., Ltd.—Total profit for 1916, £24,469. Net profit £11,930, subject the Excess Profits Duty for 1915 and 1916. The debit at December, 1915, was £10,687, so that in the balance sheet the profit and loss account now shows a credit of £1,243. Meeting: March 16th.

British Insulated & Helsby Cables, Ltd.—Dividend, 10s. per share, plus a bonus of 5 per cent., making 20 per cent. £128,500 is put to reserve and depreciation, and £163,000 is to be carried forward.

Birmingham District Power & Traction Co., Ltd.—A petition for reducing the capital from £1,050,000 to £700,000 is to be heard by Mr. Justice Astbury on March 23rd.

Calcutta Electric Supply Corporation, Ltd.—The units sold to consumers during the four weeks ended January 26th, 1917, were 1,750,156, compared with 1,354,635 last year.

Globe Telegraph & Trust Co., Ltd.—Dividend, 2s. per share, less tax, on the ordinary shares for the past quarter.

New York Telephone Co.—The total net earnings for 1916 were $23,364,706, an increase of $3,854,166.

STOCKS AND SHARES.

Tuesday Evening.

Stock Exchange markets are firmer. There is more inquiry than stock in the case of many first-class investment securities. Sharp rises in Consols, both the War Loans, and the 6 per cent. Exchequer Bonds, have attracted renewed attention to the gilt-edged markets. Already there is much demand for high-grade stocks, despite the fact that the subscription lists for the 5 per cent. War Loan closed less than three weeks ago. Business remains quiet, but the tone is decidedly more healthy, and prices, generally speaking, are on the rise. National service work of a temporary character has been provided this week for the Stock Exchange and its House Clerks; before long, something more permanent will be offered.

So far, the rise in the investment markets has not got round to Home Railway stocks in the Underground group. Some of those in the Steam lines are better, but the recent speech of Lord George Hamilton at the meeting of the District Co. was not encouraging, though his remarks apply equally to steam and electric transport. The London General Omnibus Co. has notified that it has a very large claim against the Government, though this had no effect upon the prices of the various stocks in the Underground Electric Railways Co. The Income bonds of the holding company are lower at 82, the dividend disappointment still rankling.

Those interested in academics will find a nice point in considering what is the yield on these bonds at the present time. They have just been paid a dividend at the rate of 4 per cent. per annum, while in the previous half-year 6 per cent. was distributed. The question is, whether they can be regarded as a 5 per cent. investment or not. We work out the yield on the former basis in our tables. The £10 shares are a shade harder, and those of the shilling variety are steady at 5s. 6d.

Although prices of the Mexican industrials are unchanged on the week, the sentiment in regard to the companies is a little less cheerless. Buying has lifted the prices of two or three of the Mexican railway stocks; this served to infuse hope into the industrials. That Carranza did not comply with the blandishments of the astute German who tried to embroil him in so characteristic a plot is read as an indication of more friendliness on the part of the Mexican President than he had been thought to possess.

Moreover, one or two of the Mexican oil companies have just reported excellent progress; and although their sphere of operations is well removed from the danger zone, the mere fact of their being able to secure progressive profits in Mexico during the chaos is considered to hold a glint of hope for the others. A slender enough sunbeam, it is true, but something, at all events, to go on with.

Other foreign issues are disposed to be dullish. The Argentine Tramways stocks are heavy, in sympathy with the acute depression that has befallen Argentine railway stocks, although the reasons which contribute to the latter have but an indirect bearing upon the former. Brazilian Tractions fell to 45½, and recovered a point later, this being in keeping with the trend of other securities connected with the Republic, which fell upon flatness upon the prohibition of Brazilian coffee imports into this country, but have since partially rallied. Rio Tramway bonds of both classes continue dull, failing to recover, so far, the point or two falls that occurred last week.

The Kensington & Knightsbridge Electric Lighting Co. has reduced its dividend from 7 per cent. to 6 per cent., a result which was anticipated, as we ourselves have shown several times here. The net profit of £21,500 is about £1,000 less than this time last year, but a smaller amount came into the accounts. The price of the shares has not altered, and the market as a whole is a good one. Counties rose to 10½, and West End shares are in some demand. St. James' & Pall Mall have gained 5s. The County Co. improved its gross receipts by nearly £45,000, but the net profit of £69,400 is £6,000 less than that of a year ago. The sum of £11,000 for repairs and renewals is charged this time to revenue instead of reserve, and depreciation receives £45,000, instead of £40,000.

The Metropolitan's gross receipts rose £48,000 to £286,000, but net profit is £1,400 down at £46,900. The company maintains its dividend at 3 per cent.

Prices in the manufacturing group are good. General Electric ordinary and preference both gained 5s. British Insulated added a further 5s. to their big rise of last week. India-Rubber improved by a similar amount. Of the lower-priced descriptions, British Westinghouse preference are again being bought. On the other hand, British Aluminium have been slightly reactionary. The cable market is so quiet as to call for no special comment. Marconis have quieted down, though the market remains steady. The rubber market remains the most active in the Stock Exchange, prices being good throughout, with persistent buying of all the best-class shares.

SHARE LIST OF ELECTRICAL COMPANIES.

	Dividend 1914.	Dividend 1915.	Price, Mar. 6, 1917.	Rise or fall this week.	Yield p.c.
Home Electricity Companies.					
Brompton Ordinary	10	10	8⅝	—	£7 11 0
Charing Cross Ordinary	5	5	8⅜	—	7 8 2
do. do. do. 4½ Pref.	4½	4½	8 5/16	—	7 1 2
Chelsea	5	4	8	—	6 18 4
City of London	9	8	11	—	7 5 5
do. do. 6 per cent. Pref.	6	6	9½	—	6 1 6
County of London	7	7	10½	+ ⅛	6 16 7
do. 6 per cent. Pref.	6	6	9⅛	—	6 6 4
Kensington Ordinary	9	7	8⅛	—	5 11 7
London Electric	4	3	1	—	Nil
do. do. 6 per cent. Pref.	6	6	8⅞	—	5 6 8
Metropolitan	3½	3	2½	—	6 13 4
do. 4½ per cent. Pref.	4½	4½	8½	—	7 4 0
St. James' and Pall Mall	10	8	6½	+ ½	6 8 0
South London	5	5	2½	—	6 19 0
South Metropolitan Pref.	7	7	1 5/8	—	6 7 8
Westminster Ordinary	9	7	6½	+ ⅛	6 1 9
Telegraphs and Telephones.					
Anglo-Am. Tel. Pref.	6	6	94	—	6 7 8
do. Def.	80/-	88/6	22	—	6 16 4
Chile Telephone	8	8	6 3/16	—	5 15 3
Cuba Sub. Ord.	5	5	8½	—	6 8 6
Eastern Extension	7	8	13⅜	—	*5 16 4
Eastern Tel. Ord.	7	8	137	+ ½	*5 16 10
Globe Tel. and T. Ord.	6	7	11⅛	—	*5 19 2
do. Pref.	6	6	9⅜	—	6 3 1
Great Northern Tel.	22	22	84½	—	6 7 5
Indo-European	18	18	46½	—	6 19 9
Marconi	10	10	2 3/16	—	8 11 2
New York Tel. 4½	4½	4½	101	—	4 9 0
Oriental Telephone Ord.	10	10	2½	—	4 14 1
United R. Plate Tel.	8	8	6⅜	—	*5 5 6
West India and Pan.	1	6d.	1	—	2 4 0
Western Telegraph	7	8	13⅜	—	*5 16 4
Home Rails.					
Central London, Ord. Assented	4	4	60½	—	6 8 0
Metropolitan	1½	1	23	—	4 7 0
do. District	Nil	Nil	16	+1	Nil
Underground Electric Ordinary	Nil	Nil	1⅜	—	Nil
do. do. "A"	Nil	Nil	5/6	—	Nil
do. do. Income	6	6	82	—3	*6 2 0
Foreign Trams, &c.					
Adelaide Sup. 6 per cent. Pref.	6	6	4⅛	—	6 1 6
Anglo-Arg. Trams, First Pref.	5½	5½	2⅝	—	9 11 4
do. 2nd Pref.	5½	5½	2⅝	—	—
do. 5 Deb.	5	5	64½	—	7 15 0
Brazil Tractions	4	4	46⅛	—	8 12 0
Bombay Electric Pref.	6	6	10	—	6 0 0
British Columbia Elec. Ry. Pfce.	5	5	60	—1	8 6 8
do. do. Preferred	—	Nil	43	—	Nil
do. do. Deferred	—	Nil	37½	—	Nil
do. do. Deb.	4½	4½	64	—	6 12 10
Mexico Trams 5 per cent. Bonds	—	Nil	25	—	Nil
do. 6 per cent. Bonds	—	Nil	22½	—	Nil
Mexican Light Common	Nil	Nil	7½	—	Nil
do. Pref.	Nil	Nil	14½	—	Nil
do. 1st Bonds	Nil	Nil	27½	—	—
Manufacturing Companies.					
Babcock & Wilcox	14	15	22	—	6 9 1
British Aluminium Ord.	5	7	27/6	—6d.	5 8 0
British Insulated Ord.	15	17½	12⅜	+ ⅛	6 17 3
British Westinghouse Pref.	7½	7½	2 7/16	+ 3/32	6 9 10
Callenders	15	20	12½	—	8 4 0
do. 5 Pref.	5	5	4	—	6 5 0
Castner-Kellner	20	22	8⅜	—	6 10 8
Edison & Swan, £3 paid	Nil	—	⅜	—	Nil
do. do. fully paid	Nil	—	1⅜	—	Nil
do. do. 4 per cent. Deb.	4	4	61½	—	6 10 1
Electric Construction	6	7½	1	—	7 10 0
Gen. Elec. Pref.	6	6	9½	+ ½	6 6 4
do. Ord.	10	10	14	+ ½	7 2 10
Henley	20	25	15	—	8 6 8
do. 4½ Pref.	4½	4½	4	—	6 12 6
India-Rubber	10	10	11⅜	+ ½	*8 10 2
Telegraph Con.	20	20	37	—	*6 15 2

* Dividends paid free of income-tax.

FIGHTING HAIL AND STORM BY "ELECTRIC NIAGARAS."

The damage done to agriculture by hail is sufficiently serious in this country, but it is vastly greater in many other lands. In France, for instance, the loss by hail is estimated at £4,000,000 per annum, a sum so large that there is every encouragement to tackle seriously the problem of eliminating or controlling hailstorms, instead of merely distributing inadequate sums from public funds in compensation for the damage done. Hail cannon, rockets, bombs, explosive balloons, siren kites, and such like devices are more or less effective in "softening" hailstorms in their immediate vicinity, and even in reducing the storm to rain, but little can be done against violent cyclonic storms by these means, and well-organised "firing" on a large scale is necessary to deal at all certainly with slowly-moving storms.

From ordinary experience, one is quite prepared to admit the probability of hailstorms being governed (or, at any rate, affected) by the electrical conditions of the atmosphere. This probability is supported by authentic records of serious hailstorms all over the world; such storms are generally "thunderstorms," and it is generally easy to trace cause and effect in lightning discharges and the increased violence of hail which follows. The firing of hail cannon, &c., may achieve its purpose, but there is reason to suppose that it does so by changing the electric potential of the lower layers of air and clouds, and, by suppressing lightning, prevents the formation of hail. Many theories have been evolved to account for the connection between electricity and hail. Thus Volta considered the formation of hailstones to be due to the combined effect of cold produced by evaporation and of electrostatic attraction and repulsion of ice-particles. Another theory is that the shock caused by a flash of lightning, or the vacuum formed temporarily along its path, leads to local rarefaction of air and such evaporation of moisture as cools surrounding particles to freezing point. The difficulty is to explain how one or a few flashes can control the hail-fall over an area of hundreds of acres, if in reality they do so.

There seems not the slightest doubt that, in France at any rate, disastrous falls of hail are always preceded by violent lightning, generally from cloud to cloud. Also, in districts much subject to storms, the latter tend always to follow the same route. Storm charts show remarkable regularity in the lines representing the course of storm clouds, and also show the constant influence of mountain peaks. In Western Europe, and particularly in France, the prevailing direction of storms is from the West towards the North-East and East.

Lightning Conductors and Hail.—Granted that there is a close association between atmospheric electricity and hailstorms, it is obviously better to attempt some direct control over atmospheric electricity than to use weapons which can only be operative by secondary effects. Experiments conducted in France during the course of several years past have shown that a carefully-arranged system of lightning conductors is very effective in warding off hailstorms, and a detailed statement of the ways and means employed is given by Jean Escard in *La Lumière Electrique*, whence these notes are derived. The idea of using vertical conductors to fight storms and hail is a very old one. During the second half of the 18th century hail rods (*paragrêles* or *paragrandines*), consisting of long masts terminating in a copper point connected to ground, were tried in France and Italy. About that time, Franklin suggested the use of numbers of lightning conductors to diminish the frequency of storms, as well as to protect buildings; and in 1783 Abbé Berthelon devised his *électro-végétomètre* to collect atmospheric electricity by a multiple-pointed lightning conductor. The primary object of this device was to stimulate growing crops, and it has formed the basis of many later systems of "electroculture," as well as of most of the protective arrangements since proposed for use against hail. Following successful trials with wooden posts, the brass-pointed tops of which were connected to earth by a conductor of hemp and straw, more than a million hail rods were installed in France, Switzerland, Italy, Bavaria, and on the banks of the Rhine by the year 1825. A generation later Beckensteiner patented a system for "combining increased crops with freedom from destructive atmospheric conditions" by using a *large number* of hail rods *particularly on heights*, each rod consisting of a painted resinous pole about 65 ft. high, and fitted with a copper finial (with four or five branches) and a galvanised iron conductor to earth. Practically the same equipment was used by Frestier and Chabert in successful electroculture and protective investigations between 1885 and 1895. Convincing testimony as to the efficacy of such equipment is afforded by the great reduction in storm damage in the neighbourhood of the Pic-du-Midi Observatory. Since 14 lightning conductors were fitted to the building in the 'nineties, the claims in respect of hail and lightning damage have been very few.

In 1901, Dr. Clément (Lyons) published several notes emphasising the importance of using many hail rods, and of placing them on all high ground. The rods should not be placed simply in the area to be protected, but should be arranged to form a sort of "storm wall," or barrage, at a little distance away, and in the direction from which storms usually arrive. There is, of course, no objection to making the protection more complete, but the "outposts" are the first essential. Clément recommended that the hail-rod should consist of a long metal strip reaching well above surrounding objects, and terminating at each end in a large sphere or disk. The whole of this system should be insulated from earth, and a short distance above ground there should be a metal "exciter," consisting of a bowl near the lower sphere and connected to earth. Such a system would discharge intermittently and carry off large quantities of electricity from a storm cloud. Naturally, it would be very dangerous to approach the "exciter," which should, therefore, be effectively screened.

Electric "Niagaras."—The electric "Niagaras" of Négrier and Beauchamp, so called because they discharge large quantities of electricity into the earth, consist of rectilinear batteries of large lightning conductors carried by lofty lattice masts and terminating in branched finials. It has long been recognised that natural obstacles (forests in particular) form barrages, giving a great deal of protection against hail; indeed, many districts are almost perfectly protected by large woods surrounding them. The genuineness of such protection is well authenticated. The natural barrage is analogous to regiments of lightning conductors, or to enormous condensers preventing storms from breaking and preventing the formation of hail-clouds.

When there is "no electricity in the atmosphere" there is no hail, and even when the atmosphere is highly charged electrically there is no hail if the air be saturated with moisture. A dry and highly-charged atmosphere is very favourable to the formation of hail. As it is impracticable to increase the humidity of the atmosphere by artificial means, all that we can do to reduce the hail risk is to dissipate the electrical charge of the atmosphere as much as possible. In order to do this it is only necessary to know how atmospheric electricity behaves, and how it acts on the atmosphere. Thereon depends the whole science of protection by electric "niagaras." The function of "niagaras" is rather to drain away atmospheric electricity (in the form of a steady brush discharge to the conductor, and so to earth) than to cause or encourage actual flashes of lightning, because hail is generally precipitated by the latter.

The potential difference between the earth and the upper layers of the atmosphere is enormous,* and normally increases with altitude (the air being charged positively). In other words, at higher altitudes one approaches more and more to an ideal source of electricity—a reservoir of enormous capacity. The charges of atmospheric electricity are being renewed continuously (by air movements, &c.), and it is quite impracticable to establish permanent conductors between the upper atmosphere and earth in sufficient numbers to keep the atmosphere "drained" of electricity. All that we can do is to suppress more or less effectually the sudden discharges which cause storms. This may be accomplished by lofty fixed conductors which "drain" passing clouds of their electrical charge, and so safeguard adjacent territory which it is desired to protect.

The first "electric niagara" to be erected in France (in 1899) consisted of a large metallic pylon terminating in a radiating sheaf of pointed copper bands, connected electrically to a water course. This equipment was erected at St. Julien l'Ars, which used to suffer more frequently than any other place in Poitou from hail and storms. The protection afforded proved to be so effective that several other towns soon voted funds for similar equipments, subsidies were obtained from local authorities, and Senators and Deputies have raised the matter in Parliament with a view to protecting the whole of France against hail and storm. When hail does fall in the neighbourhood of electric niagaras, it is in the form of "soft hail"—friable and practically harmless, little more than snow.

Before the St. Julien "niagara" was erected, damage by hail was frequent and severe, and the value of the crops destroyed increased as the vineyards were extended. Directly the "niagara" was installed there was an unmistakeable decrease in the storm damage. For 13 years past no damage has been caused by lightning, and hail has done no appreciable damage, such as has fallen being quite soft. *In all the neighbouring communes the damage done by storms has remained as serious as ever.*

(To be concluded.)

Conductivity of Air and of Mica.—M. Branly, at a recent meeting of the Paris Academy of Sciences, reported that he had had occasion to investigate the resistance of piles formed of a large number of thin sheets of white mica; and, observing certain anomalies, was led to believe that the conductivity was appreciably increased by the existence in these sheets of very fine circular holes. Experiments, still in progress, have been made with a simple circuit comprising (1) a source of electric supply, (2) two metal plates between which is inserted a fine sheet of mica, either plain or perforated, (3) a galvanometer. It appears that the gaseous layers imprisoned between the sheets are liable to become gradually and freely conductive.

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*Tests at Glossop Observatory showed a potential higher than 100,000 volts at 400 metres above ground.

SOME POINTS IN CONNECTION WITH ENGINEERING SPECIFICATIONS.

By J. SHEPHERD, M.I.E.E.

(*Paper read before the* Institution of Electrical Engineers *at Leeds.*)

(*Concluded from page* 249.)

Laying Cable Conduits.

In a large underground electrical distribution system the cables are either drawn in or laid solid, and both systems have their advantages.

For a large town with expensive surface reinstatement, the solid system is unsuitable; whilst for an urban district the draw-in system is too costly.

The work of laying cable ducts is very similar in character to that of laying gas or water pipes. The method adopted by one of the Government Departments was to pay a fixed rate per lineal yard of work actually carried out, the contractor taking the risk of difficult work, and having to stand the loss of work partially completed but abandoned owing to obstructions encountered later.

Such a method of contracting is open to many objections, as the work becomes too speculative, the unknown quantities being too great. Either the contractor loses a lot of money or else he provides large amounts for contingencies which may or may not arise.

For work of a similar character which the author has carried out, the specifications for the work, though more elaborate, were found to be fair to both parties in so far as difficult work is paid for if met with, at tendered rates set out in the bill of quantities, and, if difficult work is not met with, the contingencies provided for do not require to be met.

The general body of the specification contains but little novelty, the chief interest being in the bill of quantities, which is divided into three sections, as follows:—

(A) *Duct-laying* of various numbers of cable ducts laid in every kind of roadway or pathway construction. The rates tendered per yard run. Cover excavation to normal depths and widths, removal of useless obstructions, lighting, watching, fencing, &c., carting away surplus material, levelling the bottom of the trench, laying conduits or pipes in cement, concrete, and mortar, filling in the trench, ramming and permanently reinstating the surface, testing each cable-duct line, including the cartage of the ducts from the nearest depôt.

The rates tendered cover work laid both at normal depths and in trenches of normal width. If, when carrying out the duct-laying, deeper trenches or wider excavation be found necessary, adjustment in rates are made, as afterwards described.

(B) *Construction of Manholes.*—The manholes for drawing in the cables are spaced about 100 yd. apart, and are of two types and various sizes, to suit the bank of ducts.

The work of constructing the manholes is divided into the following sections:—

(*a*) Excavation of the ground.
(*b*) The foundation upon which the box is built.
(*c*) The brickwork of the box.
(*d*) The construction of the top or cover of the box.
(*e*) The permanent reinstatement of the surface, whether road or footway.

If the manholes are of standard size, the rates tendered directly apply. If they are of necessity greater in depth or width, the new prices can be immediately built up from other rates, given in the next section.

(C) *Miscellaneous works* of all characters which may be required, such as excavation for extra depths or for extra widths, extra bricklaying at various depths, rates for concrete laid at various depths, timbering left in trenches, steel or cast-iron piping, paving, and surface reinstatement of every kind, &c.

In practice it has been found to be comparatively simple with a specification of this character, and with a comprehensive schedule of prices, to adjust at once, and to price up all work of usual difficulties. When, however, the work becomes of extraordinary difficulty, involving excavation in water, running sand, or the like, provision is made in the specification for the contractor to carry out the work on a prime cost basis, plus 15 per cent., but in only one case during 11 years was it found necessary to resort to this method.

Work to the value of £250,000 has been carried out to specifications of this character with but one dispute, where a particular class of work had been incorrectly priced and the estimated quantities of that class of work were largely exceeded.

Sub-station Switchgear.

Having no less than 23 sub-stations containing rotating machinery of from 2,000-kw. to 6,000-kw. capacity, the problem of purchasing switchgear became one of importance.

Two methods were adopted. At the commencement general requirements to be met were stated, leaving the maker to supply his standard apparatus to meet the conditions laid down. Three sub-stations were equipped in this way by two contractors; one for the high-tension apparatus, and the other for the continuous-current feeder panels. The result was not satisfactory. One contractor supplied his panels of marble, the other insisted on slate; and the two classes of panels had varying widths and heights. These difficulties, however, were minor matters compared with other troubles met with.

Within six months the low-tension panels had practically to be rebuilt, and within six years the high-tension panels had to be scrapped to suit Home Office regulations.

For all later sub-stations the second method was adopted, viz., to issue working drawings of all the panels and apparatus and to loan to the contractor parts for interchangeable manufacture.

The method was entirely satisfactory to the purchaser; competitive tenders on equal footing were obtained, and sound and interchangeable switchgear was purchased, requiring a minimum quantity of spare parts.

It became a simple matter to interchange panels from sub-station to sub-station as conditions of load required.

All high-tension switchgear was contained in brick cubicles, and but two accidents occurred during 10 years' working. In each case the damage was confined to the one cell where the short-circuit occurred.

There are, of course, drawbacks to such a system of purchasing. It is not adapted for purchases on a small scale, and it becomes difficult with standard designs to introduce modifications from time to time, which otherwise in a smaller system would be adopted. On the other hand, the maintenance of such switchgear was particularly good, amounting to practically nothing on the high-tension side, and it was generally confined to renewals of circuit-breaker contacts on the low-tension side.

It became possible to standardise such details as all porcelain insulators, and a sheet of standard porcelain was loaned to each contractor in turn.

Reconstruction of Motor-Generators.

After working continuously night and day, several of the earlier motor-generators began to fail from various causes, such as soft cores, broken core teeth, brittle insulation on the armatures and stators, charred insulation on the shunt windings, &c.

After careful consideration it was decided to provide a renewals fund on the basis of reconstruction every 10 years, and the first year's programme included the reconstruction of 17 motor-generators of 300-kw. and three motor-generators of 500-kw. capacity. An estimate of the cost of the work was furnished to the financial authorities, and the makers of the plant were approached for prices. As the results were by no means comparable, a specification was drafted, working drawings were got out, and tenders invited by advertisement, the prices tendered being:—

(A)	£7,987 10s.
(B)	£8,330
(C)	£14,100
(D)	£20,321
Engineers' estimate ...	£11,500

The lowest tender was that of a firm practically unknown, but a visit to their shops proving satisfactory, the contract was let to them at the price tendered, and the result was in every way satisfactory.

Owing to improved methods of winding with "hairpin" formed coils, a much sounder construction resulted, giving an increase in output of 25 per cent. on the original rating, and a renewal of life to certainly another 10/15 years.

The machines were originally constructed in 1902 and 1906, and the frames were then liberally proportioned.

The contractors who carried out the work took on further contracts at substantially the same rates.

General.

Having described in brief outline a few specifications covering various branches of engineering, the author would by no means dogmatise, or even go so far as to say that the only way to buy engineering plant is by specification. It is, however, the only way he knows of by which one can purchase plant on the conditions laid down. A free agent can purchase on different lines if he is free to select his tender, no matter what the price may be; but, even so, a clear specification as to what is offered is necessary both to limit the supplier's responsibility and to define his liability. The basis of all contracts depends upon much besides the wording of a specification, and implies fair and reasonable dealing on the part of both supplier and purchaser, without haggling on the part of the supplier or needless complaints or meddling by the customer's engineer. In conclusion, the author would remark that, to specifications such as those described, over £2,500,000 worth of work has been purchased, and of that large sum not more than £1,500 was spent abroad, and that for articles which were not manufactured in this country. In the past a large amount of foreign purchasing has taken place, resulting in the foreign manufacturer frequently escaping rigid inspection, burdensome general conditions, exacting wage rates, and other labour conditions. This condition of affairs is not, however, likely to be repeated during the next 10 years, nor, it is to be hoped, for a much longer period.

ECONOMIC RECUPERATION AFTER WAR.*

By PROF. W. R. SCOTT, D.Phil., Litt.D., LL.D., F.B.A.

(*Concluded from page 230.*)

So far as the argument has been developed, grounds have been adduced to indicate that industry can be restarted after the war upon an adequate scale. Still, the approximate magnitude of that scale is of vital importance. Here the labour supply—both as to quantity and quality—must be considered. No one can yet estimate with precision the probable total of the killed. In addition, there will be all those wholly or partially disabled by wounds and disease. Therefore an initial survey of the position, as regards labour, shows a large deficit in the supply as it existed before the war. And so, upon a hasty inspection of the situation, it might be concluded that, not only was capital likely to be deficient after the war, but, still more, industry would be cramped for a number of years by a very material reduction of labour. But this estimate only considers the quantity of the labour in employment immediately before the war. There is, first, the extension of that quantity. The war has revealed in most of the combatant countries unanticipated reserves of labour. Men past the prime of life, and also women, have discharged many functions in industry which were new to them. Naturally, this new supply of labour is to some extent an emergency one, but its existence shows that after the peace a large augmentation of the quantity of labour is possible. There is still the question of efficiency. The progress of hostilities has proved that several countries have been working on too narrow a margin of skilled labour. In order to carry on the industry of the country, it has been necessary to train large numbers of new workers; and, after the war, the skill of these will remain as a potential national asset. It is true that in some cases agreements have been made with the Trade Unions that the employment of workers, unskilled before the war, in specified skilled trades during the war, is to be purely temporary. While this arrangement will be loyally observed, scope will no doubt be found for these lately trained workers in new industries which will, no doubt, be rendered possible by the progress of inventions, while it may be that a much better organisation of industry may be arranged, so that industries may be reconstituted that neither employers nor employed would desire to return to the pre-war conditions. A great and just war such as this has been the means of a quickening of the national spirit, partly through the awakening it has experienced, partly under the spur of necessity. Invention will be greatly extended, and new discoveries will play their part in the restoration of prosperity at a later date. Then the consequences of the Napoleonic wars may be repeated; and, as they were followed by the great Victorian era of invention and industrial progress, so the war of the twentieth century will be succeeded by a similar period. And that epoch will follow the war more closely than the developments of the nineteenth century; for war has now become so mechanical that it has evoked the best energies of thousands of inventors. Some of these discoveries will be capable of adaptation to the uses of peace; while, in other instances, the augmented capacity of the inventors will be available, and will be more efficient than if it had not been evoked by the present tragic circumstances. Besides, this principle of substitution will be at work, and further introduction of labour-saving machinery will take place in cases where its efficiency can be demonstrated. Indeed, even during the war, there have been instances in which already such machines have been devised and used upon a comparatively extended scale. In fact, just as the watchword of the first years of peace in the provision of capital will be the continuance of economy, so in the case of labour, economy in its use will also be necessary. Moreover, it is to be hoped that the nations of Western Europe will respond to Nature's demand for population; and that in this case, as in that of previous wars, there will be an improvement in the birth-rate. Thus the terrible waste of humanity may be repaired—in the first instance by continuing to use so far as necessary the reserve of labour called up by the war, and later by a larger proportion of births and a reduction of infantile mortality.

Some considerable friction in the readjustment of the *post bellum* supply of labour to the demand for it is inevitable. Exclusively war industries, which, during hostilities, have been incessant in their call for labour will begin almost at once to reduce their staffs. Conversely, other trades which were suspended, or whose operations were seriously contracted, will be anxious to make a fresh start after peace. Moreover, demobilisation will return men from the Colours to the avocations of peace time. In this process it would appear that confusion, with resulting temporary unemployment, would be inevitable. No doubt this would follow if demobilisation were as sudden as many of the mobilisations have been. But various conclusions indicate that demobilisation will take place by stages, and, therefore, industry will have a better chance of reabsorbing the labour which was displaced in order to undertake military service. Any radical change in tariffs would increase the difficulties in the reabsorption of labour.

It is possible that after the war the scale of operations of many industries will be considerably changed. An important alteration in tariffs would cause a great reduction in some trades and an increase in others. Thus important bodies of skilled workers upon their return might conceivably find the demand for their labour very largely reduced, and it would be small immediate compensation to them to learn that there was a wide field for workers in another trade which had increased. Further, if, as seems to be necessary and unavoidable, the first years of peace will witness a continuance of war economy, though to a modified extent, then the luxury trades must suffer, except to such extent as some of them can add to their otherwise reduced output by producing for export in order to replace some part of the lost home consumption. But the consuming power of that part of the world, which is at present neutral, would not suffice to absorb that portion of the production of these trades which is likely to be displaced from the home market. Accordingly, it is to be anticipated that in this, as well as in other directions, important variations in demand are to be anticipated. Still, too much stress need not be laid upon the inevitable dislocation of industry upon the return of peace. One of the discoveries of the war has been (as I have endeavoured to point out in my presidential address to the Economic Section of the British Association in 1915) the great extent to which specialised labour and capital have been able to adapt themselves, soon after the outbreak of hostilities, to meet new and unexpected demands. In this respect, at least, it may be anticipated that the converse movement, when the war is over, will be less, rather than more difficult.

What, then, is to be the general conclusion? Speaking from the data at present available, and with due reserve for the absence of information concerning some of the belligerent countries, and in view of all the circumstances as to how long the waste of war is to continue, I may perhaps describe my general results as those of a conditional optimist as regards the state of Europe during the first decade after peace has been made. Dangerous as similes are in economic reasoning, one may afford some light upon the situation which is likely to result. As regards those nations in Europe which are at present combatants, let us imagine an owner of land who is at the same time engaged in some productive occupation, and who has become involved in a serious law suit which menaces both his vital interests and his property. The time spent on preparing his case, as well as the anxiety, lessens his income from his occupation, and he finds himself compelled to disburse great sums unexpectedly in legal costs. He is forced to mortgage his property, and when the contest in the law courts is ended, he must pay the interest on the debt, and as soon as possible begin to repay the principal. This will mean that many improvements on his property which he had planned may require to be postponed, and certainly he will need to curtail his luxuries, it may be even many of his comforts. Further, the magnitude of his expenses will be the measure of the period of his sacrifices. He is, in fact, exchanging as against one huge, immediate, unproductive expenditure, the future unproductive expenditure of many years to come. The duration of his privations may be contracted by extra efforts in augmenting his production, either by increase of efficiency or by additional work. Here a nation has an advantage over the imaginary individual of our illustration. In a sense, it is always young. A time of privation forces new activities, and it enables progress to be hastened. In a measure the population of a country, just recovering from the losses of war, resembles the individual bondsman of the early English plantations in North America, where the man, who was in earnest, worked at high pressure to liquidate the debt and to attain his economic freedom as soon as possible.

To continue the parable, just as the losses of war will fall with varying incidence on different countries, so a detailed examination of the position of various litigants in the circumstances indicated will reveal interesting individual differences. One may have been forced to pledge his property very deeply, and at burdensome rates of interest. Should he lose his case and be mulcted in damages, then his affairs are likely to suffer serious embarrassment for a long time afterwards. The whole business of another may be seriously disarranged; yet, even though for a few years his estate may yield him little if any return, a successful issue will enable him in time to re-establish his fortunes. In the case of a third, it may happen that relief will come through the cessation of a state of relations with his neighbour which gravely impaired the development of his property and the pursuit of his legitimate activities.

Such seems to be the future position, symbolically represented. Can we see it more perfectly as it will be in its essentials? That at present is scarcely possible. Some of the important factors are unknown, or only partially known; it may even be that others have not yet revealed themselves. But one thing may be expected—namely, that the general burden will be very considerable. Combatant nations cannot anticipate the unproductive expenditure of future years and transform it into present unproductive expenditure in war without experiencing the pinch of a certain amount of want for a considerable period in the future. In the words of the proverb: "One cannot eat one's cake and have it too." We in 1916-17 are, so to speak, eating the cakes of 1917 to, let us say, 1927, or even later. In the intense national preoccupations upon national existence (as each nation conceives it), and in the grief of so many families for the fallen, the

*Read at the Institution of Engineers and Shipbuilders in Scotland, February 20th, 1917.

burden is not fully realised. Consciousness of it will come when, after the peace, life endeavours to return again to its former courses. Then the burden of present unproductive consumption in war will be felt, and in preparation for that time it is the duty of Governments to endeavour in advance to adjust that burden to the capacity of those who have to bear it. Equitable adjustment of taxation and improved organisation of commerce and industry will do much to make the people more capable of sustaining the load they will have to carry. In particular, should we not learn something from what may be described as one of the paradoxes of the war—namely, that while there never has been a war in which material appliances have been so important, at the same time it is no less true that, conversely, there never was one in which immaterial wealth, or even moral ideals, were so supreme? And towards repairing the waste of war, an important function will belong to the immaterial. Activity of mind and flexibility of intelligence to seize the opportunities of the new peace (which may differ from that peace which was shattered by the war); inventiveness to advance man's conquest of Nature (which in reality is man's co-operation with Nature), economy in the employment of the resources (both human and material)—all these will shorten that period during which the sacrifices, which the present demands of the future, must be endured.

THE PARALLEL OPERATION OF ELECTRIC POWER STATIONS.

The paper by Mr. J. S. Peck, on the above subject, was read and discussed at the meeting of the Western Local Section of the Institution of Electrical Engineers, at Bristol, on February 5th.

Mr. W. A. Chamen (engineer and general manager, South Wales Electrical Power & Distribution Co.), in opening the discussion, said that some considerations regarding the question of changing the periodicity of one system to suit that of another might be useful. It was obvious that such a course was always desirable in the interest of simplicity and of the highest efficiency, and in many cases no doubt it was quite possible and a proper course to adopt, but in the case of a supply concern having a considerable number of large consumers, many of which were collieries, the problem was exceedingly difficult, if not impossible, and the cost prohibitive. New plant in the power station would require to be put down before the original plant could be thrown out of action. So far as the plant was concerned it might be possible to change it over piecemeal, and it might even be possible to follow the same course with regard to the main switchboard, which was usually duplicated as regards the bus-bars, so that the new plant could deliver to one set of bus-bars while the old plant could deliver separately to the other. But the real difficulty would arise in dealing with feeders upon which perhaps several large consumers might be grouped together. The periodicity of supply to all these consumers must obviously be changed at one and the same time, which meant that the consumers must be dealt with simultaneously. Coming now to the consumers' installations, the worst difficulty of all arose. Most of the new periodicity plant would require to be provided in readiness for the change, and in many cases it would be impossible to get the motors delivered below ground and transmitted to their various destinations at the same time that the old motors were being taken out except by arranging for periods of "shut-down" of such duration as no colliery would be likely to be able to bear. It would involve practically the construction of duplicate engine houses or pump houses underground, so that the new plant could be ready when the periodicity was changed. The time taken to carry out such operations and the cost of them would clearly be prohibitive. The transmission of motors and other heavy machinery along the underground roads must all be arranged and carried out in such a way as not to interfere with the ordinary working of the mine, and this in itself would be the cause of very serious delay. It might be taken, therefore, that changing over the periodicity of an extensive system of supply was, practically speaking, quite impossible. It followed that in the cases of the linking-up of power stations running at different periodicities we should be often driven to the use of frequency changers. He knew of one instance of linking-up of power stations of different frequencies where energy was sometimes transmitted in one direction and sometimes in the other, in which it had been thought desirable to construct the frequency changers with motor ends of the induction type and with generator ends of the synchronous type, coupling one in the one direction and the other in the opposite direction, so that the induction end should always be the motor in one or other of the sets, according to the direction in which the load was being transmitted. He gathered from Mr. Peck's reply to the discussion that this was not really necessary and that frequency changers with synchronous machines at both ends could be used with safety. The fear expressed in regard to this arrangement was apparently that one station might tend through overload to drop its speed slightly and that the synchronous machines, allowing of no slip, would be liable to destruction by being called upon suddenly to transmit loads altogether beyond their capacity. This, however, seemed simply to point to the necessity for having the frequency changers of ample capacity to deal with any situation which might be likely to arise in practice, and for the use of reactances, automatic overload circuit breakers, or other protective devices to prevent injury to the machines in case of abnormal conditions arising. Surely, after all, this question could not be really different from that of linking-up two power stations of the same frequency, because the same question of the carrying capacity of the inter-connecting cable and of the necessity for protecting it against excessive and abnormal loads must obviously arise there.

Mr. C. G. Morley New (deputy engineer and manager, Cardiff Tramways) agreed that stations could be operated in parallel without difficulty, and for that reason could not understand the emphasis the author laid on speed regulation. Interconnector voltage would have to be carefully considered, as it was probable in many instances that the linking-up system of to-day would be the transmission system of the future, and extensions to generating stations would only be carried out in the most suitable places. He saw no reason why reliable automatic devices could not be installed for the purpose of earthing a system, in the event of the interconnector opening. He was interested in the Scott system of transformation in dealing with single-phase load from a three-phase supply, and was not at all satisfied as to the effect on, say, phase "A" during a severe overload such as a fault on phase "B," seeing that the neutral point on the three-phase side was not fixed. In the author's fig. 3 the neutral point was shown earthed, which was contrary to the Board of Trade regulations, if the system was already earthed at the generating station. He would like to know if there was any objection to dealing with one-phase load from a three-phase system by ordinary transformer connections, three-phase mesh connected to three-phase 4-wire, the neutral point forming an earthed outer to the single-phase system. In many cases it was not more difficult to balance three circuits than two. Having had experience with all types of sub-station converting machines, he could say that the induction machine was the most stable, as the synchronous plant as often as not shut down when faults occurred outside.

Mr. A. T. Kinsey (Bristol Post Office Telephones) said that telegraph circuits still used the earth as a return conductor, and as the current employed on them was measured in milliamperes it could readily be seen which circuit was likely to suffer if powerful currents traversed the earth. Since the introduction of electric tramways telegraph engineers had constant differences of potential between any two earths irrespective of distance, and in general not much notice was taken of them at the present time so long as they did not exceed 2 volts, as their effect could be eliminated. In telephony, owing to the extreme sensitiveness of the apparatus, the use of the earth as a return conductor had long been discarded and all public circuits were now metallic. Moreover, the tendency was to terminate such metallic circuits on transformers, so that the transmission circuit proper would be quite independent of the earth. There were, however, large quantities of apparatus used in signalling and in supervision which were auxiliary to the transmission circuit, and they relied upon the use of the earth. It could therefore be seen that telephone engineers as well as telegraph engineers would view with great concern any transference of load from one power station to another if it meant that large alternating currents of high frequency would pass through the earth.

Mr. T. J. Nelson (Port Talbot), in a communication, said that the paper provided a strong argument for the standardisation of frequencies, as the difficulties that arose with the parallel working of power stations appeared to be in connection with frequency changers. The parallel working of two power stations having different frequencies had been successfully carried out in South Wales at the "New Markham Pits" of the Tredegar Iron & Coal Co. These new pits had a supply from two existing stations belonging to the company situated at Tredegar and Oakdale, which had different frequencies, Tredegar being 40 cycles and Oakdale 50 cycles, and frequency-changers were used to interlink the two stations. Two motor-generators were installed, one with an induction machine on the 40-cycle side, and the other with an induction machine of the 50-cycle side, thus enabling the two sets to float on both systems without loading either supply with wattless current. The synchronous machine could be excited to such a degree as to give wattless current equal to, or exceeding, that taken by the induction machine connected to the same bus-bars. The first set consisted of a 750-B.H.P., 600-R.P.M., 3-phase, 50-cycle, 6,600-volt induction slip-ring motor rigidly coupled to one 500-KW., 0.8 power factor, 3-phase, 40-cycle, 6,600-volt synchronous generator. The second set was of similar output. Two liquid starters were provided for starting the induction motors, and two sets of resistance grids were permanently connected in series with the rotors of the induction motors to give approximately 1½ per cent. additional slip at full load. The provision of slip-ring motors with adjustable permanent slip resistance provided, as it were, a flexible coupling between the two stations so connected. It was not necessary that the two stations should run in exact synchronism. The frequency of one station might vary approximately 2½ per cent. in either direction without overloading the frequency-changer set. Suppose that the Tredegar station kept exactly a frequency of 40 cycles, if the machines at Oakdale were overloaded, the

speed of the prime movers would have a tendency to drop, but in the same measure as its frequency dropped below 50 cycles, one of the frequency changers would transmit power from Tredegar. If the drop were approximately 2½ per cent., then 500 KW. would be transmitted in that direction, with one frequency-changer running, and 1,000 KW. if both were in service. On the other hand, if the prime movers in Oakdale had a light load, their speed would rise over the normal frequency, and power would be transmitted from Oakdale to Tredegar. The condition for the smooth working of the plant was that the governors of the prime movers in both stations should cause a few per cent. speed drop from no-load to full-load. This condition applied in general to prime movers driving alternators for parallel operation. The outside adjustable slip-ring resistance allowed the slip of the frequency-changer to be brought into line with the regulation of the governors in both stations. This would not be possible with squirrel-cage motors. The provision of slip-ring motors with starting resistances also simplified the synchronising of the sets. When two stations were running in parallel only one neutral point should be earthed, or if it were required to earth the two neutrals, it might be done by inserting transformers in the interconnecting line, as suggested by the author. He had known this method to give entire satisfaction, but if the transformers were not required for any other purpose, it was not necessary to go to the expense of installing them. He did not agree that reactance or resistances should be placed in the earth connection to limit the earth current to a negligible value, as it was important that the earth resistance should be low enough to allow sufficient current to flow through it, to open any feeder on the system.

Prof. David Robertson said that the figures which Mr. Peck gave as to the size of frequency changer necessary for connecting two systems made one wonder whether it would not be better to change over the smaller system in every case in which it was at all possible to do so. Since the changer set involved both a motor and generator, if it had to be rated as high as 20 per cent. of the capacity of the smaller system it would cost somewhere about 40 per cent. of the electrical equipment of the station, and would thus go quite a long way towards paying the station part of the cost of changing over to the standard frequency. Of course, there would be the consumers' motors to change as well, which, as Mr. Chamen pointed out, would be quite impracticable in some districts. With the object of illustrating Mr. Peck's statements and calculations about the operation of machines in parallel, he gave some locus vector diagrams based on the same approximate theory as Mr. Peck's equations and explained them in detail.

Mr. J. S. Peck, in reply, agreed with Mr. Chamen as to the great difficulties involved in changing over a large generating station from one frequency to another. Where a station was isolated from other stations in the same district, due to a different frequency, it was worth considering when laying down new plant whether to couple two generators to one turbine, one generator to be wound for the frequency of the station, and the other for the frequency of the district. The advantage of a set with two generators was that it could be driven by the turbine and supply current at either or both frequencies, or it could be used as a frequency changer to take energy from either system and supply it to the other. If the installation referred to by Mr. Chamen and Mr. Nelson were being installed to-day, the two sets would probably be replaced by a single double-synchronous set. Where two or more very large stations were connected together by short lengths of cable, it would be highly desirable to install reactance coils in the interconnecting lines, otherwise a short-circuit on any part of the system might produce serious disturbances, and perhaps shut down all the generating stations. He did not think earthing devices were usually very reliable, and believed it was much better to earth the neutral point through a resistance, especially where balanced protective gear was used. The Scott system of connection for changing from three-phase to single-phase would not give a balanced load on the three-phase circuit unless the two single-phase circuits were equally balanced. This then became, in effect, a two-phase system. With Prof. Robertson's remarks he was in general agreement.

ELECTRIC SHIP PROPULSION.*

By W. L. R. EMMET.

The writer has for many years actively advocated electric drive for the larger vessels of the navy, and as a result of a long campaign of designing, experimentation, and educational activity this method has been adopted on a large scale by the Navy Department. Electric propelling machinery has been ordered for the last seven battleships which have been authorised, and is specified for the four new battle cruisers which form part of the present naval programme. These battleships are very large and important vessels, requiring 33,000 H.P. each, and the battle cruisers present the most stupendous propulsion problem ever brought forth, since they require no less than 180,000 H.P. each. Only two or three of our cities use as much electricity as will be generated on one of these ships at 35-knot speed.

Electric propulsion has from the first had many opponents, and it is still being very actively opposed by nearly all the shipbuilders of the country, by Sir Charles Parsons, Charles G. Curtis, and others who have had important influence in marine engineering. Most of this opposition is undoubtedly sincere, but is not altogether disinterested, since shipbuilders want to use machinery which they know how to build, and since turbine inventors have in the past received large royalties from turbine-driven ships which are cut off by the advent of electric drive. Although the power still comes from turbines, the electric drive is, by licence agreements, free from royalty charges.

The case of the new battle cruisers may be considered as the extreme case where advantages are most important and in which the disadvantages of increased weight are most serious.

Four of these vessels are authorised in the Navy Bill of 1916. They are designed to make 35 knots each, requiring 180,000 H.P. delivered to four shafts turning at full speed about 250 R.P.M. These are the fastest and most highly powered vessels ever built. The electrical installation proposed in each of them far exceeds in extent any single installation ever made for any purpose.

It is proposed to install in these ships four high-speed turbine-driven generating units of the best type, similar in most respects to those used in power stations on shore. Upon each of the four propeller shafts will be mounted two independent induction motors. Cable connections and switching arrangements will be provided by which any combination of motors and generators can be immediately obtained, and by which all the changes of connections for operation, reversal, &c., can be instantly made under all running conditions; they are quite simple—in fact, much simpler than in most electrical installations. The electric supply is produced for the one purpose of propulsion, and is varied or discontinued according to need. Connections are changed only on dead circuit, even in the ordinary operations of stopping, starting, and reversing, and automatic means are provided by which any diversion of current from any cause produces an unbalancing which instantly breaks the field circuit and de-energises the system.

The aggregate weight of this equipment with cables, switches, instruments, and controlling apparatus is 1,865 tons.

If such a vessel were gear driven, a plurality of ahead turbines would be connected through helical gearing to each propeller shaft, one or more backing turbines would also be connected through the same gearing, and if good cruising economy was sought, it would be necessary to provide also cruising turbines connected through separate systems of gearing and arranged with couplings so that they could be detached during high-speed operation.

Without further description or discussion of either type of apparatus, we are in a position to make a comparison which constitutes one of the most important advantages of the electric drive. In the geared equipment, each shaft has a system of turbines, gears, bearings, thrust balancing devices, and lubricating systems all mechanically locked together. With high-speed machinery any kind of trouble with any of these parts will almost certainly necessitate the immediate stoppage of the whole system. To keep a high-speed turbine running out of balance or with bearing trouble is impossible, and the gearing part would present almost equal difficulty. In the event of mechanical trouble of such character a ship would have to be stopped until the wreck could be cleared. The work necessary to uncouple and disconnect any part of such very heavy apparatus would be a serious matter involving much time, including that required to stop the ship. After the disconnection was made, the idle propeller would act as a very serious drag on a fast vessel.

In the electrically-driven ship there is no mechanical connection of the shaft to anything but the rotors of the motors. These are self-contained, ironclad structures, and cannot by any possibility be subject to mechanical interference. The shafts are subject to the same possibilities of bearing or thrust trouble as shafts in other ships, but the presence of the motors does not increase this danger, and the speed being low it is remote in any case. With this equipment any motor, generator, or turbine, if in any kind of trouble, can be instantly disconnected without stopping the ship, and with only a small loss from the highest speed capacity.

Such interchangeability as this power of disconnection gives constitutes one of the most important advantages of electric drive in such a ship. With one motor out of eight in trouble, only one-eighth of the maximum capacity is lost, and the ship's maximum speed is impaired by only about one knot. If a generator or turbine is in trouble the maximum speed is reduced only about two knots. With two generating units and four motors out the ship can make 26 knots, and with three generators and four motors out she can make 19 knots. If parts give trouble they are simply cut out and repaired at leisure or as opportunity offers. The value of this interchangeability is a warship can hardly be over-estimated; it largely overcomes the military danger incident to accidents to the driving power, a danger which has always been of primary importance.

In turbine-driven ships, not electric, it is necessary to

*From the *Electrical World*. Abstract.

provide backing turbines which must run idle in the reverse direction when the ship is going ahead. These backing turbines involve complications which are very objectionable, and if these are reduced to a desirable minimum the backing power will be greatly inferior to that easily provided with electric drive. Experiment has shown that a turbine forced in an opposite direction involves about seven times as much friction loss as when driven in its normal direction. This loss is very appreciable in the backing turbines of ships, and causes heating which must be dissipated by circulating steam, which causes further loss and waste. There are also serious difficulties and dangers in high-speed apparatus incidental to the abrupt and wide changes of temperature where steam is suddenly admitted to a cold reversing turbine. Steam which expands without doing work has a high temperature, and if work is done upon it by a reversed turbine the heat is considerably increased. With superheat these temperatures may be extreme, and they affect the main turbine as well as the other, since it also must be used for reversal of direction, and since the two often occupy the same casing. The mechanical effect of such abrupt change of steam temperature upon fragile structures presenting very extended surfaces is a matter which has been little considered, but which has caused much serious trouble. With electric drive the turbine never need be stopped when the ship is under way, and its operation is easier than in a power station, because the load is steadier. With modern high-speed turbines superheat affords large gains in fuel economy, and the ability to use safely high degrees of superheat may constitute one of the important reasons for adopting the electric drive.

Various statements and estimates have been published concerning losses in high-speed gearing for which the authority is not known by the writer. Tests at Schenectady have shown losses about double those generally estimated, with rapid diminution of efficiency as the load falls. These tests were of a most accurate character with large smooth running gears, and by the motor-generator method, where losses alone were measured, the same power being transmitted with and without the gearing.

With the electric drive in these battle cruisers, the losses from turbines to propeller shaft at full speed will amount to 7 per cent., and by adjustment of voltage the transmission efficiency can be kept equally good at all speeds. Considering gearing losses, reversing turbine losses, losses incident to necessary sub-divisions of the turbine and additional packings, it is believed that the actual transmission from turbine blades to shaft at full speed cannot be made more than 2 per cent. better in the geared equipment than it is in the electric. At reduced loads the geared equipment will be much less efficient. The normal cruising speed of these ships will require less than one-tenth of full load, and the drag of gearings, bearings, reversing turbines, and idle parts of main turbines will be very serious.

With the electric design, the number of motors and turbines used can be adapted to the demand for power, while with the other all parts must be kept running. This gives very important gains in economy at all speeds below the maximum. At 19 knots only one turbine is required to drive the ship, and electrical arrangements are may by which it can be run at full speed instead of running at half speed, as it would if the ratio was fixed as by gearing. Thus the steam efficiency at 19 knots, a desirable cruising speed, is equal to the best attainable at any speed. Assertions which have been made by shipbuilders and others that equal cruising results can be obtained by the use of cruising turbines are obviously absurd. The cruising turbines themselves would be greatly inferior to the single main turbine so used, and they would be burdened with all the drags which are mentioned above. Cruising economy gives increased cruising radius without renewal of fuel supply. This has always been considered a matter of the greatest importance in warships; it is a feature in respect of which the electric drive can have no rival.

Enough has been said to give an idea of the reasons for the use of electricity in such ships, but, in addition, it should be considered that everything used in such an electric installation is a matter of exact knowledge and wide experience, while methods of gearing on such a scale are backed by little and brief experience, and are the subject of wide difference of opinion as to methods of design and proportions.

The writer believes that the differences of weight and cost which have been predicted by shipbuilders and others are not based upon just comparisons, but that even if they are true they are not sufficient to balance the practical merits of electric drive for such vessels.

For these reasons, it is believed that when prejudices are overcome electricity will develop an extensive use in large high-power warships. In such light vessels as scouts and destroyers, for reasons of weight and space, it is relatively much less desirable, but even in such cases with the lightest and most compact designs, and with very high pressure and superheat, it might in the future develop a legitimate application. In merchant ships also it may afford great advantages. With electricity, turbine units can be installed in duplicate, either in single or twin-screw ships. Machinery can be installed where convenient with motors near propellers and turbines near boilers, auxiliaries can be driven electrically from the main units. The highest superheat can be used without danger or complication, and main units can be applied to other power uses, such as cargo pumping or handling. These advantages have led to the preference of electric drive at a higher price in certain large freighters recently ordered, and will doubtless lead to many other applications in ships of various types.

The advantages here mentioned have been developed with a wonderful skill and foresight by the Swedish engineer Ljungström in the 900-H.P. ship *Mjolner*, which has been in successful operation for about two years. This vessel has shown a fuel economy decidedly superior to anything produced elsewhere in a steamship, and has maintained this high standard throughout her period of service. Such a result with such small power is very remarkable and significant. The *Mjolner* uses an extremely high degree of superheat.

NEW PATENTS APPLIED FOR, 1917.

(NOT YET PUBLISHED).

Compiled expressly for this journal by Messrs. W. P. Thompson & Co., Electrical Patent Agents, 285, High Holborn, Londno, W.C., and at Liverpool and Bradford.

2,439. "Temperature compensators for electrical control devices." British Thomson-Houston Co. & General Electric Co. February 19th.
2,475. "Electric switches." T. McLeod. February 20th.
2,487. "Electro-magnetically-operated contact makers or switches." F. C. Hibberd, W. King and G. D. Peters & Co. February 20th.
2,488. "Electric motor-control systems." British Thomson-Houston Co. and General Electric Co. February 20th.
2,494. "Manufacture of armature driving spindles." F. R. Simms and Simms Motor Units, Ltd. February 20th.
2,505. "Operation of electric or magnetic apparatus." F. J. Moffett. February 20th.
2,507. "Wireless telegraphy and telephony." I. Hortik. February 20th.
2,525. "Electromagnetic levitating and transmitting apparatus." T. P. C. Smith. February 21st.
2,564. "Terminal or gripping devices for electric conductors." Benjamin Electric, Ltd., & E. Fowler. February 21st.
2,570. "Automatic control of electric generating sets for emergency or stand-by purposes for ships, buildings, &c." G. C. Pillinger & L. Sunderland. February 21st.
2,574. "Interrupter cams for operating ignition in internal-combustion engines." H. de la Valette. February 21st. (France, February 25th, 1916.)
2,582. "Electrical oscillating apparatus." G. C. Evans & Submarine Signal Co. February 21st.
2,591. "Electrical driving gear for motor-cars, &c." H. Crochat. February 21st. (France, December 15th, 1916.)
2,600. "Means for rendering liquids radio-active." O. A. Elias. February 22nd.
2,601. "Artificial cooling of electric motors and generators." G. E. Preece & P. J. Williams. February 22nd.
2,617. "Protective devices for alternating-current electric systems." A. E. McColl. February 22nd.
2,621. "Electrical massage generators and appliances." E. Peckham. February 22nd.
2,623. "Tank for oil-break switches." A. Reyrolle & Co. and R. W. Gregory. February 22nd.
2,624. "Oil-break switches." Electrical Improvements, Ltd., & R. W. Gregory. February 22nd.
2,639. "Electric signalling or indicating apparatus for signalling orders or numerical data, &c." E. A. Graham. February 22nd.
2,650. "Combined electric generating and self-starting mechanism for motor vehicles." E. Aron & E. Hill. February 22nd.
2,656. "Receiving apparatus for wireless telegraphy." G. A. Beauvais and L. N. Brillouin. February 22nd. (France, March 27th, 1916.)
2,657. "Telephone installations for wireless telegraphy, &c." G. A. Beauvais & L. N. Brillouin. February 22nd. (France, November 7th, 1916.)
2,674. "Fittings or supporting combinations for electric lighting, &c." J. S. Foreman. February 23rd.
2,691. "Controllers for electric circuits." British Thomson-Houston Co. and General Electric Co. February 23rd.
2,701. "Process of treating ores of copper and nickel by electrolysis." M. V. Garin (*née* Bailly). February 23rd. (France, February 29th, 1916.)
2,707. "System of signalling in coal mines, &c." P. Holmes. February 23rd.
2,718. "Pocket electric torches or flash lamps, &c." C. Allaun. February 24th.
2,740. "Electrostatic machines." D. K. Morris. February 24th.
2,741. "Electrostatic generators." D. K. Morris. February 24th.

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1916.

The numbers in brackets are those under which the specification will be printed and abridged, and all subsequent proceedings will be taken.

1,540. Electric Impulse Senders. Relay Automatic Telephone Co. & H. J. Herink. February 1st, 1916. [103,683.]
1,863. Thermic Telephones. Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. February 13th, 1915. [100,084.]
2,491. Electrical Fuses or Cut-outs. H. W. Cox. February 19th, 1916. [103,712.]
2,864. Integrating Mechanism for Measuring Instruments. British Thomson-Houston Co. (General Electric Co., U.S.A.). February 25th, 1916. [103,714.]
3,298. Electric Switches. A. H. Midgley and C. A. Vandervell & Co. March 4th, 1916. [103,719.]
4,347. Telephone Systems. T. Pettigrew. March 23rd, 1916. [103,732.]
4,606. Ship Propulsion. British Thomson-Houston Co. (General Electric Co., U.S.A.). March 29th, 1916. [103,733.]
9,232. Dynamo-electric Machinery. W. Marden. June 30th, 1916. [103,766.]
10,558. Duplex and Multiplex Telegraphy. G. O. Squier & L. A. Cohen. July 26th, 1916. [103,771.]
11,435. Rotors of Electrical Machines. Allgemeine Elektrizitats Ges. August 6th, 1915. [101,158.]
13,905. Cooling and Ventilating System for Electric Storage Batteries in Submarines. M. F. Hay. September 20th, 1916. [103,792.]
1,410. Signalling Appliances. W. A. Heyes, L. O. Heyes & A. V. Heyes. January 26th, 1916. [103,676.]
5,733. Day and Night Compasses. G. Leigh. April 19th, 1916. [103,748.]
13,392. Tramway and Railway Rails. C. Spreckley. September 20th, 1916. [103,786.]